

No. 212

Vol. XLVI Part 3

July 1961

GEOGRAPHY



*Journal of the
Geographical Association*

Price 10s. 6d. net

Free to Members of the Association

THE GEOGRAPHICAL ASSOCIATION

The Geographical Association, founded in 1893, exists to further the knowledge of geography and the teaching of geography in all categories of educational institutions from preparatory school to university, in the United Kingdom and abroad. Membership is open to all who are interested in geography or in education. Privileges of full membership include the receipt of *Geography* (four issues a year) and, in the United Kingdom, the use of the library of books and periodicals. Facilities exist for student, school and college membership at special rates, and local branches exist in England, Wales, Scotland and Northern Ireland for the organization of lecture and excursion programmes for members in their vicinities.

The annual subscription for full membership is £2 (\$6.10 if sent in U.S.A. currency), due on 1st September. Oversea members should send subscriptions by sterling transfer with their local currency or by cheques drawn on banks in Great Britain for the full amount of the subscription. Cheques and postal orders should be crossed and made payable to the Geographical Association. Branch members may pay their full subscriptions through their local branch secretary or treasurer.

Correspondence and inquiries should be addressed to the Honorary Secretary at the Association's headquarters:

The Geographical Association,
c/o The Park Branch Library, Duke Street,
Sheffield 2.

Subscriptions and general inquiries should be addressed to the Assistant Secretary, who will supply information leaflets and application forms for membership on request.

Correspondents requiring a reply should enclose a stamped self-addressed envelope. Members are asked to advise headquarters office at the above address of changes in their addresses, as far in advance as possible.

Geography is published in January, April, July and November and is sent free to all members. Copies are available to non-members at 10s. 6d. each and information about back issues and part-sets will be supplied on request. Information for contributors to *Geography* is given on the back cover and further details will be supplied on request.

Geography may also be obtained on trade orders from the Association's publishers:

G. Philip and Son, Ltd.,
32 Fleet Street, London, E.C.4.

OFFICERS AND COMMITTEES 1961

President: Mr. GEOFFREY E. HUTCHINGS

Chairman of Council: Professor H. J. FLEURE

Hon. Secretary: Dr. ALICE GARNETT *Hon. Treasurer:* Dr. L. DUDLEY STAMP

Hon. Librarian: Mr. L. J. JAY *Hon. Asst. Treasurer:* Mr. W. R. A. ELLIS

Trustees: Prof. W. G. V. BALCHIN, Prof. E. G. BOWEN, Mr L. BROOKS, Dr. L. D. STAMP

Hon. Editor: Professor D. L. LINTON

Editorial Board

Mr. T. H. ELKINS
Professor N. PYE

Mr. L. J. JAY
Dr. H. ROBINSON

Miss M. OUGHTON
Professor M. J. WISE

Assistant Secretary and Assistant Editor: Miss M. OUGHTON

PRIMARY SCHOOLS SECTION

Secretary: Mr. A. F. SPRANGE, 120 Galleywood Road, Chelmsford, Essex

PUBLIC AND PREPARATORY SCHOOLS SECTION

Secretary: Mr. J. D. FROMANT, Clifton College, Bristol 8

SECONDARY SCHOOLS SECTION

Secretary: Mr. ROGER COLE, 2 Beacon Drive, Walsall, Staffs.

FURTHER EDUCATION SECTION

Secretary: Mr. J. WADE, 107 Kilmartin Avenue, London, S.W.16

TRAINING COLLEGES SECTION

Secretary: Miss E. THURMOTT, Philippa Fawcett College, 94 Leigham Court Road, London, S.W.16

STANDING COMMITTEE FOR TEACHING AIDS IN GEOGRAPHY

Secretary: Mr. D. A. E. TAYLOUR, 39 Lynton Road, New Malden, Surrey

STANDING COMMITTEE FOR FIELD STUDIES

Chairman: Professor S. W. WOOLDRIDGE, King's College, London, W.C.2

Climate and the Geomorphic Cycle

Address to the Geographical Association

A. AUSTIN MILLER

President 1960

A WAY FROM THE SEA with its unmistakable features of erosion and deposition there is obviously a difference between pure glacial landforms, pure desert landforms and pure fluvial landforms. Glacial landforms, however, are no longer pure: they are still clearly recognizable in northern Britain though fading southwards and rapidly losing their salient features as fluvial erosion rubs out the work of ice. Glaciated valley profiles for example are being re-shaped by normal weathering, slowly blunting the break of slope in the cross-section at the upper limit of former glaciers, while frost-shattered scree and down-wash derived from the steep valley walls smooths the sudden break below the wall of the over-deepened trough. In the longitudinal profile stream erosion slowly eats back and grades the *verrous* or valley steps while glacial lakes are drained and fluvio-glacial terraces produced. Further south, however, and nearer the limits of Pleistocene glaciation the disappearing evidence of past glaciation is more difficult to identify. It takes a good geomorphologist to recognize a moraine in the Chiltern Hills or the Goring Gap or to convince others of the climatic conditions under which, say, Coombe Rock was formed in Sussex.

Much more difficult and controversial are the changes at the arid boundary. Thus the northern Sahara, now a true desert with inland drainage, shows some river valleys which, it is thought, were formerly graded by continuously flowing streams, but are occupied today only by rare flash floods that die in the desert, brought to a slow halt by too much mud and too little water. In desert climates rain is rare but very heavy when it does come. The Karun River, in south Persia, has an average discharge of about 300 cubic metres a second, but occasionally it flows for a few days or hours at 5000. There are huge sudden inundations and the river overflows its banks and escapes onto the plain. Sheet erosion takes control and shallow flood waters sweep the ground of loose debris, the products of the mechanical weathering characteristic of deserts. The sheet flood soon produces pediments, and fans of debris (*bajadas*) are spread at their feet, gradually burying first

► Professor Miller delivered his address at the London School of Economics on 2nd January, 1961, during the Annual Conference of the Association.

the pediments and eventually the hills and mountains in the products of their own decay. There is no outlet from such basins of inland drainage but the flood waters last a little while before evaporation, and the finer-grained fragments accumulate in the playa which eventually dries and leaves a clay flat that rests on the fading edge of the bajada. Constant repetition of the process at each flood, however rare, carries salt in solution which is always left in the same playa; so the playa becomes and is preserved as a salt pan or salina. Wind and dust-devils carry the finer material hither and thither, and if the wind direction is constant, it accumulates on the leeward side. So there are old dunes, now fixed, on the southern (leeward) edge of the Sahara, where the vegetation began, acting as a trap. The wind detritus only escapes from the basin where there is an exit to leeward, as in the loess deposits of China where the monsoon is constant and regular in winter. But is Shansi a desert any longer? And is the loess still accumulating? Or is it a product of glacial times?

The relics of Pleistocene geomorphology still survive but they are passing away; is the desert, too, changing its distribution? There are plenty of definitions of deserts, but we can be satisfied with a definition that loss of water by evaporation so far exceeds the gain by rainfall that the waters cannot escape and the catchment area becomes a basin of inland drainage. It is true that there are rivers, like the Nile, the Colorado and the Columbia, that escape from their basins by reason either of their alimentation beyond the desert borders, or of having inherited a course established by wetter conditions in the pluvial Pleistocene. Yet some of the bolsons, for example in Mexico, show evidence of recent increase in rainfall. They now overflow the bolson rims and are cutting down their exits and dissecting the playas that accumulated there in their desert days. Climates are obviously changing; but we can go no further until we have established a closer relationship between climate on the one hand and the evolution of relief on the other.

The need for new approaches

W. M. Davis treated the normal cycle as one of rivers and fluvial erosion, but readily recognized a notable difference of events where glaciers do the work and later he wrote an essay on the aeolian cycle wherever, as in deserts, wind became an important means of transportation. In fact he stressed a difference of "process" resulting from a change in the medium of weathering and transportation; but he gave little regard to the intensity of operation of the medium, such as rainfall, as an important factor in evolution of landforms.

Since his pioneer days the physicists and chemists have applied more elaborate and quantitative tests to glaciology, hydrology, aerial dynamics or soil chemistry. Though an increasing number of geographers have applied their findings to questions of glacial and arid

landscapes, few English-speaking geographers have applied the physical and chemical behaviour of soils, and the effects of temperature on, for example, the development of landforms in the humid or semi-humid tropics. The Germans and French have behaved more wisely and most of the work on the influence on soils of weather and in due course their influence on erosion is in their languages. It is 25 years since Karl Sapper wrote *Geomorphologie der feuchten Tropen* and in his *Précis de géographie physique générale*, published in 1959, Pierre Birot devotes as much as fourteen pages to a chapter on the vegetation and landforms in the humid tropics and a further 55 to his eight principal morpho-climatic variants and their geomorphology. In English textbooks, though the glacial and arid cycles are fully treated, the equatorial forest, the savanna and the steppe receive Davisian treatment—nothing at all. Even in Cotton's *Climatic Accidents* only two chapters are devoted to inselbergs and savannas; the rest is devoted to periglacial, glacial and arid climates; nor are the humid tropics treated in American textbooks outside the climates that occur in North America. On the other hand, in the numerous books on soil that I have consulted there is no mention of the influence of climate on relief, though there are plenty of references to the influence of relief on soil and vegetation catenas, etc.

Yet when I was shown the tropical landscape of Ceylon by Dr. Kularatnam, or of Malaya by Professor Dobby, I was intrigued by many geomorphological features unfamiliar in Britain. And going from Rio de Janeiro to Santos in the company of Brazilians, Germans and Frenchmen who had worked in the tropics of West Africa, Central America and, of course, Brazil, I opened my ears, but held my tongue as they all seemed on good familiar terms with the landscapes and landforms we were seeing in selvas and campos, whether it was the Sugar Loaf, the Serra dos Orgaos, or the Serra do Mar; the Campos de Jordão, the Campos Cerrados or the Baixada Fluminense. It is to these striking variants of relief in what would probably be called the "normal" cycle of fluvial morphology in hot climates that I propose to limit myself in what follows.

Nowadays the soil scientist, the botanist and even the zoologist study the effects of climates on the soils, the vegetation and the ecology, and frankly they study them with a degree of quantitative accuracy that makes the geographer seem very qualitative indeed by comparison. So the geographer must be ready to listen to their findings and interpret them all together, and when considering relief features to reconstruct the climate of the locality at the time of their formation.

Furthermore, the human geographer reminds us that for the last two or three thousand years man has either changed the climate or modified its effects. Forest clearance has turned the natural vegetation in Europe into agricultural land; the best and the most fattening pastures depend on grassland, now well known to be luxuriating in

a climate that could support forest. Much of the savanna "grassland" is said to have lost its trees by fire, natural or man-made, and fire prevents the re-establishment of forest. Man-made clearances for agriculture are apparent. But fire seems to be nearly as important in virgin territory little occupied by cultivators; it is often started by lightning, especially with the storms that usher in the first rains when everything is tinder dry.

The operation of land-forming processes is fundamentally different in the two contrasted sets of climatic factors that prevail; hot and permanently saturated on the one hand, hot and dry on the other, and these will therefore receive separate treatment. Finally, in any landscape in which rivers flow there are two fairly separable aspects in the evolution of relief, one is the work of rivers, both by erosion and deposition, and in their spacing; and the second is the weathering of interfluvial areas, the preparation of their weathering products for removal and the formation of soil and vegetation catenas. The former is quantitatively studied by the hydrologist, the latter closely concerns the pedologist. Both concern us here but I will consider them separately, dealing first with the preparation of the interfluvial areas for removal of waste and then with the river pattern and the function of rivers in removing those products of waste.

Rock weathering and soil formation

Different rocks react differently to weathering processes, influencing the rate of lowering of terrain and the relative quantity of soluble and insoluble weathering products, but it is one of the contributions of Russian pedologists who dealt with fairly uniform geology but considerable climatic diversity that climate slowly takes the upper hand and in the last stage of soil evolution becomes the dominant factor, whatever the original geology may have been. So climate becomes the real factor in weathering at least. In desert climates, where water is scarce and runs quickly away, mechanical weathering predominates; but where rainfall is abundant the water remains for a long time in the spongy soil and in contact with rocks, so that the chemical reactions it produces are thorough and complete. Consequently where rainfall varies seasonally, i.e. in Mediterranean or savanna climates, chemical weathering and the removal of soluble products is at its maximum in the wet seasons, but dwindles during the drought when the mechanical weathering characteristic of deserts takes charge. On the other hand, wherever temperature varies with the seasons, though rain continues, the rate of weathering varies in intensity with the seasons, for chemical weathering is greatly accelerated by a rise in temperature. According to Polynov chemical weathering is almost inactive at the very cold temperatures in the Arctic; in temperate climates it is three times as rapid as in the Arctic, since the relative dissociation of H_2O into H^+ and OH^- ions multiplies, and of course it is much greater at the higher

temperatures that exist in the longer summer season. In humid tropical climates weathering operates at full speed throughout the 365 days of the year, with a relative dissociation three times as great; the "weathering factor" of the tropics is therefore ten times as rapid as in the Arctic and more than three times as fast as that in temperate climates. Polynov then gives the following table of the relative rates of solution of the products of weathering of rocks, common salt being taken as 100:

1. Salts	
Chlorides	100.00
Sulphates	57.00
2. Bases	
Calcium	3.00
Sodium	2.40
Magnesium	1.30
Potassium	1.25
3. Silicates	0.20
4. Sesquioxides	
Iron	0.04
Alumina	0.02

From this it can be seen that the salts, including some of the most important plant nutrients, go into solution at once, and in areas of heavy rain, are carried away in solution, eventually down to the sea. An early estimate of the age of the earth was based on the salinity of the ocean, assuming that it had started "fresh". Others, like nitrates and phosphates, are quickly washed out of the rocks. They are needed as fertilizers and have to be replaced artificially in wet climates like Britain's. They have survived and been mined in the deserts of Chile or preserved as the guano of sea birds on the desert islands off its coast. At higher temperatures the solubility of most salts increases rapidly; so in hot climates, as tropical agriculturalists know, the life of soluble fertilizers is very short indeed. The bases, again important as plant nutrients, are also quickly impoverished, but the silicates and sesquioxides stay behind, though washed down into the B horizon. They make most of the mineral material in pedalfers (e.g. podzols, and the deep laterites of the tropics). There is still some argument about the production of laterites, but it can be shown that the solubility of colloidal silica increases rapidly at high temperatures and in humic acid waters, and the quantity of silica present in laterites is small. In fact the ratio of silica to sesquioxides in the clay fraction can be taken as a measure of the duration of time that the weathering products have been subjected to tropical humid conditions. Laterite is less a soil than a completely weathered rock and it may be very thick indeed, thick enough to mine as a source of aluminium; it has no fertility in itself.

On the other hand, podzols have a layer of silica beneath the topsoil and below this a layer enriched by fine grained humus or of iron oxide, in contact with the weathered rock. The actual soil layer is only a few inches thick, though in the tropics laterites can be, and often are, 20 feet or more in thickness.

Vegetation too plays its part, contributing leaf litter and dead grass which makes humus, but the humus is destroyed more rapidly in hot climates where it has a brief but active passing life. Worms redistribute it, so do ants, termites and other insects, and micro-organisms play their part in its destruction. Thus the natural vegetation, which appears to be very closely related to the climate, makes its contribution to the soil, and so does man, who burns the grasses, sweeps up the leaves, ploughs the soil, adds fertilizer, rotates and inter-cultivates the crops, and so on.

THE GEOMORPHIC CYCLE IN HOT CLIMATES WITHOUT A DRY SEASON

Temperatures are in the eighties or nineties by day, and drop perhaps 20°F by night, the humidity is always high and a warm mist often hangs among the trees. Very rarely is there a dry season, the soil is constantly wet, saturated in fact, and run-off is rapid and constant. The conditions of temperature and humidity are so favourable to life that the number of genera and species of plants and trees is almost infinite; the botanist is overwhelmed but the seeker after a useful species, e.g. *Hevea brasiliensis*, must slash his way over a wide area to find them.

As there is no seasonal rhythm growth is continuous; there are no annual rings, leaves are shed at any time of the year, flowering and fruiting, though perhaps started off for each tree by some climatic event, may well be out of step with their neighbours. So tropical forest produces two or three times as much organic matter as the leaf fall of an oak wood, mainly because there is no halt in plant growth. Lianes clamber up the trees, some of them climbing through damp steamy air to the very tops of the giants and flowering in triumph there. Tree roots are shallow, for only the surface layers of soil contain nutrients, some send out flying buttresses, others have supporting roots, the trunk thickening above their junction as the roots bring more nourishment to the stem. If a tree dies it cannot fall but hangs like a corpse suspended by lianes and leaning drunkenly against its neighbours, until it rots or is eaten by insects and slowly disintegrates.

Insects are everywhere, flies, butterflies, mosquitoes and ants; there are flying frogs and climbing lizards and snakes, but running animals are rare, though climbing ones are abundant—monkeys, sloths, rodents, and, in Australia, marsupials. Movement on the ground is not easy, even to fly zig-zag among the trees is difficult, and most of the birds and animals are slow-moving vegetarians or fruit-eaters.

Weathering in tropical humid climates

Two things are most important in the weathering of rocks and the formation of soil—the climate and vegetation. In the equatorial forest a mat of decomposing vegetation is forming very fast and being destroyed equally fast. The rocks are rotting fast and deep, the soil is

forming quickly and its fertile but soluble products are being leached just as readily. The forests in fact are living on the products of their own decay and were it not for constant renewal of fertility by leaf litter and decaying vegetation they would quickly fade. Normally the forest cover acts as an umbrella and the rain drips heavily off the leaves, but where the trees have been destroyed the destructive force of torrential rain erosion can be fully unchained and if there is any slope then the topsoil is quickly washed right away. So primitive forest clearing may lead to a good crop for a year or two; after that the soil rapidly becomes exhausted, and a shifting cultivation must shift. Even in flat relief heavy rain splashes onto the bare soil and soaks away carrying the surface fertility with it. If there is a slope, gullying begins and quickly the soil is washed away. Thus in the untouched forest itself the fertile topsoil is shallow, but beneath it the products of weathering are very deep and quickly formed. The great depth of weathering shows itself in the construction of roads on the weathered rock. In the process of making them the deeply weathered spurs of hills can be easily bulldozed into the valleys giving a road above flood level, with alternating cuttings through spurs and embankments across valleys. Gradients are avoided and the line is straightened. If the rocks contain cementing material a carapace is formed in the temporarily well-drained area, but there is certainly no doubt that the interfluvial areas of tropical climates are "prepared for removal" by erosion (Penck's *Aufbereitung*) with great rapidity. This is what makes them so vulnerable to soil erosion when cleared of their protective covering of forest. The differing degrees of resistance to erosion offered by various types of rock are important, in high relief especially. In addition to the obvious factors (joints, direction of bedding planes, etc.) there is the interesting point that some rocks, e.g. hornblende-rich rocks, produce at once on weathering heavy clays (often with some montmorillonite) which seal off the remaining rocks from the influence of percolating water and slow down further decomposition and are often associated with relatively shallow roots and sometimes with flattish relief.

Pedologists have written much about granite weathering. The biotite weathers easily and the feldspar breaks down into clay, leaving crystals of quartz that go to make loose sand mixed with clay. If the relief is low these are fixed and covered with trees and bound by their roots in the surface layers but in high relief and on slopes too steep for soil retention "sugar loaves" and "half-oranges" result. They are typical of the steep slopes of the Serra do Mar, both at Rio de Janeiro and again on the remarkable rock summits of the Serra dos Orgaos that form a fantastic back-drop behind the coast. These seem to owe their existence to massive granite rocks, convexly exfoliated by the release of pressure through rapid unroofing, for spalling is commonest in rocks that have been unburdened of a thick heavy load. The products

weathering of
granite

of spalling fall away from very steep slopes and are rapidly reduced to material of a fine calibre that is scattered by the waves on the coast. On the mountain tops, e.g. the Serra dos Orgaos, the sugar loaves are attacked from the sides by the rapid retreat of slopes and are quickly converted into sands and clays and go to join the downhill movement of rock waste.

It is true that there are some regions of fairly low relief where the outcrops of coarsely jointed granite blocks lie at the surface but such fields occur in regions of present-day cultivation. And it is true that core-stones, with wide jointings, are often exposed fairly near the surface in quarries or road cuttings, but they rarely survive in nature to form "tors" at the surface. By the time they come within three feet of the surface they are broken up by granular disintegration, for they are surrounded by weathered rocks, constantly saturated and at temperatures sufficient for rapid decomposition. It is only by chance that they emerge and having emerged are temporarily arid. This is shown by their vegetation which includes cacti and other temporary evidence of aridity as the rain runs off quickly and leaves the plant baking in the sun.

Limestone and the wet tropics

The *competence*, or hardness, or resistance of rocks to erosion obviously affects the rate of weathering and erosion, especially in youthful stages of the erosion cycle, but this competence varies according to the nature of weathering, whether frost action, as in cold and temperate climates, or reaction to temperature variation, as in deserts, or chemical weathering in wet climates. This would be a huge subject, but it is worth mentioning the reaction of limestones and the peculiarities of their behaviour in tropical climates. The karst regions in Jamaica are well known and the work of Meyerhoff in Cuba and Porto Rico has shown that there these regions are normally karstic, provided that the limestone is above the water table. There are limestone hills known as *mogotes* or "haystacks" as much as 1800 feet in height with flat karstic tops, separated by wide dry valleys with near vertical sides and drainage is mainly underground.

But in the lowlands of the humid tropics limestones are "weak" and undergo such rapid weathering that the area of their outcrop forms a depression. The reason for this seems to be as follows. The soil and the rocks are saturated with water, stagnant or slowly moving and at work dissolving the limestone at all levels. Furthermore the water is acid, derived from the humus layer of the forest and though the water at saturation could hold less carbon dioxide than at the lower temperatures of higher latitudes it is acid due to the humus, so it is permanently saturated; thus the limestone suffers a steady dissolution. A hollow is formed, spreading along the line of outcrop which becomes slowly filled with bauxitic material derived from above and becomes a swamp from which the water finds difficulty in escaping by normal run-off.

The work of rivers in equatorial climates

Now let us see how the weathered rock is dealt with on delivery to the streams and how the streams shape their beds. This is clearly related to the angle of slope. The pattern of drainage consists of frequent closely spaced gully-like streams, as a consequence of the heavy rainfall, which results in rapid, fairly regular and continuous run-off. The stream prevents the formation of forest whose edge forms a sudden change from land protected by trees to an unprotected water-course. The river flows over solid rocks and flowing swiftly by reason of the volume of discharge is capable of transporting the fine-grained clay delivered to it by the drainage of the slopes. Of course there is no scree or accumulation of coarse waste at the break of slope beside the river, so that streams are swift and turbulent. On steep slopes they use the broken rock of the river bed as tools and their downcutting in these reaches is rapid. But on the interfluves the top soil is matted with the roots of trees which give it a strong coherence; underneath the trees is a layer of deeply weathered rock, of a clay-like consistency. This is heavily saturated with water and readily moves downhill *en masse*, landslides being frequent. Forest often survives this translocation and remains standing though crazily tilted. The clay is delivered to the main stream and carried away at once, because of its mobility. Clay also creeps out from beneath the roots and is removed, the rate of movement being fairly rapid on steep slopes.

The result is a close pattern of steep valleys separated by forest-clad slopes of steep inclination. The steep slopes surely cannot last long, for peneplanation is rapid, and the steepness of the Serra do Mar seems to be evidence of its geomorphic youth.

Transportation by rivers

The final products of decay of the interfluves are fine grained. Under the forests which cover the interfluves the decay of rocks has reduced everything to clays and sands. Only in the river channels are bare rocks exposed and the rivers, flowing over outcrops of bare rocks, are temporarily provided with broken rocks and even these do not last long in coarse form. Yet the rivers flow fast due to the heavy rainfall, so they are generally underloaded with coarse gravel and quite capable of removing the fine waste of clay and sand. The consequence is rapid removal of waste.

Lam offers the following estimates of transport of solid materials by the rivers:

	Rhine (temperate)	Amazon (tropical)
Water flowing (cubic metres per second)	240	120,000
Solid matter (kg. per year)	2-5,000	2,300,000
Solid matter (kg. per year per km. ²)	15,000	2,000,000
Average lowering of landscape (cm. per year)	0.006	0.08

Both rivers flow swiftly and both flow over the plain, but the implication of these figures is that the Amazon lowers its landscape more than ten times as fast as the Rhine.

Summarizing, one can say that all rocks are held in a situation where chemical and biochemical weathering, i.e. their rate of rotting, is at a maximum; they are constantly hot and wet. The exception to this is in areas where bare rock is exposed in sugar loaves and half-oranges. Here the rock is hot, but temporarily dry. Run-off is instantaneous and conditions of weathering are almost desertic.

THE GEOMORPHIC CYCLE IN HOT CLIMATES WITH A DRY SEASON

It is generally believed that a long enough dry season prevents the growth of forest and encourages grass (e.g. elephant grass). A comparison of vegetational maps with the duration of rains strongly supports this and I believe it is broadly true. On the other hand, where slopes are steep in savanna climates there is often forest, and on high plateaux where the ground is flat in equatorial forest regions there is often savanna. Dr. Monica Cole suggests that the Campos Cerrados (savanna) occurring on the flat interfluvies of Brazil owe their vegetation to the soil conditions on an ancient peneplain and that the Mata (tree covered) vegetation of steeper slopes, dissecting this peneplain, is due to better drainage and more available water.

The savanna is characteristic of a hot climate with a wet season and a dry, the latter increasing in length with increasing latitude until the desert boundary is reached. During the rains the intensity rivals that of the equatorial climates, but the dry season, at its height, rivals in its aridity that of the deserts. In the wet season there is much run-off if there is a slope and much percolation if there is not. Heavy leaching in the latter case quickly removes the soluble salts and bases, and the soil loses its fertility, leached sands and clays increasing in thickness.

But with the cessation of the rains the water table falls and iron pan begins to form. On flat surfaces it forms within a few feet of the surface, but on slopes of 10° the water drains down and forms a pan at the bottom of the slope. Consequently the pan holds the rain water, giving a perched water table from which trees can feed while it lasts. If the wet season is long enough the trees may be evergreen, though xerophilous, but if the rains are short the trees must be prepared for a long dry season and shed their leaves, like the acacias. Thanks to powerful evaporation in the dry season this surface water does not long remain and shallow-rooted plants begin to wilt and the grass to turn brown.

The ferruginated layers play quite an important part in the evolution of minor landforms. Nearly always horizontal, for they form only on flat landscapes, they help to preserve its flatness. And below the pan there is probably a thick layer of subsoil clay formed by the weathering of the rocks, which has very little resistance to offer, so once broken

through they cap the hills like a sheet of basalt in our own country and finally disappear to leave a dying inselberg.

When the dry season follows, the grass dies down, the trees, if any, drop their leaves, the soil cracks and everything lies parched under a hot sun. When the rains return, they generally come in sudden thunderstorms, short-lived but torrential, and the soil is at their mercy until the grasses grow. The heavy rain runs off and overflows the banks of shallow dry water courses and runs as sheet-floods over the floor between the dead tufts of tussock grass. Where this happens on a slope sheet-floods first do their work, detrital fans are formed (some of the most fertile and well-drained areas of cultivation) and later gullies form and grow. Where the land is flat the river spreads and anastomoses over a wide area. There is no forest to confine the stream and small rivers may find themselves in new courses after the rains.

So the régime of rivers varies with the seasons; they may be in flood in the wet season, but in the dry they dwindle to dry courses with water holes. The Niger draws much of its water, it is true, from the forests of the Futa Jalon highlands, but by its entry onto the savanna it splits into a number of distributaries and between Ségou and Timbuktu is dying. This is an area where irrigation (Sansanding barrage) is now making a last use of water derived from afar, before it is lost by evaporation in the desert. The same is happening in Lake Chad which collects the drainage of the Bauchi plateau, but there has obviously been a change of climate in these cases. Doubtless there are other contributory factors, grazing, cultivating, burning, etc., which have contributed to the dominant vegetation of today. The nature of the ground and the vegetation cover and man's treatment of it affect the amount of erosion, as is shown by the following figures from the Pabbi hills in the Punjab:

Land covered with forest	3.4	cubic yards, per square mile per second
" " " bush	22.3	" " " " " " "
" " " scattered bushes	37.2	" " " " " " "
Land bare (by overgrazing)	61.0	" " " " " " "

Hot regions of regular rainfall beyond the tropics

Perhaps enough has been said to show that the important factor in the geomorphic cycle in the hot climates is the seasonal distribution of rainfall. At the one extreme there is perennial rainfall and a constantly high water table, and at the other extreme a near-permanent condition of low water table and arid condition of desert, with its predominantly mechanical weathering and just occasionally, its floods, with sheet erosion increasing to gully erosion. Between the two is an alternation of humid and arid conditions, of a water table rising to the surface in the rains and sinking again during drought. In both selva and savanna temperature is always sufficient to cause chemical weathering at a rapid speed in the wet season, but weathering is much reduced and predominantly mechanical in the dry season.

In the three southern continents the dry season does not extend to the east coast, for the Trade Winds, blowing onshore, make rain during the dry-weather season in places away from the coast. The climate becomes drier inland but a "donga" landscape is due to a sub-arid climate with episodic rain, rather than semi-arid with seasonal drought. In fact east coasts are forested throughout their length; there is no dry season to check their growth. In the region of dominant Trade Winds the rain is orographic but beyond their limits there occur frequent rain-bearing south or southeast winds of a cyclonic nature. Of course it is true that the forests have in many places been cleared for agriculture and the heavy incidence of rain on cleared soil has caused a great loss of top soil and a heavy aggradation of the rivers. This is a process through which the crude and early clearance of the southeastern States of the U.S.A. has given much reclaiming work to the Tennessee Valley Authority. But naturally the winter temperatures decrease as one goes polewards and the climate gradually becomes "normal" in the Davisian sense.

On the west coasts the Mediterranean climates have a hot dry summer when, in the natural state at least, conditions approximate to the desert with almost desert weathering and desert erosion, but in the wet winters they experience the régime of the temperate climates. Leaching goes on in winter when rainfall generally exceeds evaporation, but in the summer the water gradient is in the opposite direction and in areas of steep relief the water table goes far down. But if the water table is not far from the surface some efflorescence of salts may occur, e.g. in the Rhone delta. The rivers flood in winter but dwindle in summer to nearly nothing. This is especially noticeable in regions like Western Australia or Greece and Palestine where there are no high glaciated mountains to maintain the discharge of rivers with the melt waters of snow and ice lasting throughout the summer. Southern Europe moreover has been cultivated for 3000 years. But the Mediterranean regions of North and South America draw on the Sierra Nevada and the Andes for summer irrigation. They are most unnatural.

SUMMARY

The influence of climate on the geomorphic cycle is particularly connected with the action of the dominant agents of weathering and erosion, glacial, fluvial and aeolian. The space distribution of the operation of these factors has changed markedly during recent geological time, especially in the Pliocene and Pleistocene.

The rate at which the landscape is lowered depends on (1) the rate of weathering, i.e. the depth of rotted rock which includes the whole weathering complex, not only the soil horizons A and B but also C (weathered rock beneath), to which the plant cover contributes nothing except solvent solutions; (2) the rate of removal of the products of

weathering and, of course, (3) the rate of erosion of rock laid bare (the freeface), i.e. where the rate of removal exceeds the rate of weathering.

In hot humid climates (3) does not occur as long as the soil remains wet; it happens only where rapid run-off from bare rock converts the "sugar loaf" to a local pseudo-desert. In hot dry climates the preparation for removal is mechanical and fairly well understood, though there is some doubt about the relative effects of occasional flowing water. In the savanna (to use the only generally recognized term) the climatic conditions are alternately hot-wet and hot-dry. So it would seem that the thickness of the weathering complex, coupled with the rate of its formation, will eventually give a quantitative answer to our question. Unfortunately there is a third factor, the degree of slope. Here again is a subject for quantitative work, begun in earnest by Strahler. But as long as the work of geomorphologists remains qualitative, controversy will still proceed inconclusively on such things as peneplains and pediplains, convex and concave slopes, and the qualitative contributions of W. M. Davis, Walter Penck and Lester King.

REFERENCES

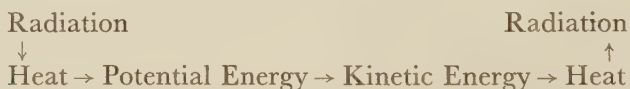
- P. Birot, *Précis de géographie physique générale*, Paris, 1959.
 T. C. and R. T. Chamberlain, "Certain valley configurations in low latitudes", *Journ. of Geol.*, vol. 18, 1910, pp. 117-24.
 A. Cholley, "Morphologie structurale et morphologie climatique", *Ann. de Géogr.*, vol. 59, 1950, pp. 321-35.
 M. M. Cole, "Cerrado, Coatinga and Pantanal; the distribution and origin of the savanna vegetation of Brazil", *Geogr. Journ.*, vol. cxxvi, 1960, pp. 168-78.
 J. Corbel, "L'érosion chimique des granits et silicates sous climats chauds", *Rev. de Géomorph. Dynamique*, vol. 8, 1957, pp. 5-8.
 J. Corbel, "Les karsts du nord-ouest de l'Europe: étude sur le rôle du climat dans l'érosion des calcaires", *Mémoire No. 12*, Université de Lyon, Lyon, 1957, p. 541.
 C. A. Cotton, *Climatic Accidents*, London and Christchurch, 1942.
 F. Fournier, *Climat et Erosion*, Paris, 1960, pp. 1-201.
 P. Gourou, *The Tropical World*, (translated by E. D. Laborde), London, 1953.
 L. C. King, "Canons of landscape evolution", *Bull. Geol. Soc. Amer.*, vol. 64, 1953, pp. 721-51.
 P. D. Krynine, "Geomorphology and sedimentation in the humid tropics", *Amer. Journ. of Sci.*, vol. 32, 1936, pp. 297-306, review and discussion of K. Sapper's *Geomorphologie der feuchten Tropen*.
 H. J. Lam, quoted in P. W. Richards, *The Tropical Rain Forest*, Cambridge, 1952, p. 207.
 H. A. Meyerhoff, "The texture of karst topography in Cuba and Porto Rico", *Journ. of Geomorph.*, vol. 1, 1938, pp. 279-95.
 V. Polynov, *The Cycle of Weathering*, London, 1937, p. 163.
 J. Pouquet, *L'Erosion*, Paris, 1951.
 K. Sapper, *Geomorphologie der feuchten Tropen*, Leipzig, 1935.
 A. N. Strahler, "Equilibrium theory of erosional slopes approached by frequency distribution analysis", *Amer. Journ. of Sci.*, vol. 248, 1950, pp. 673-96 and 800-14.
 W. D. Thornbury, *Principles of Geomorphology*, London, 1954, chapter 3.
 J. Tricart, "Division morphoclimatique du Brésil atlantique central", *Rev. de Géomorph. Dynamique*, vol. 9, 1958, pp. 1-22.
 J. Tricart and A. Cailleux, *Cours de Géomorphologie: Introduction à la Géomorphologie Climatique*, Paris, 1955, pp. 1-122 (mimeographed).
 H. Wilhelmly, *Klimamorphologie der Massengesteine*, Braunschweig, 1958, pp. 1-238.

Some Developments in Climatology during the last Decade

G. B. TUCKER

IT HAS BEEN RECOGNIZED FOR VERY MANY YEARS that one of the main problems in meteorology, and perhaps the most fundamental one, is to account for the maintenance of the general circulation of the atmosphere. By the term "general circulation" I mean the basic three dimensional flow pattern of the atmosphere together with the disturbances associated with this pattern. The atmospheric processes associated with the maintenance of this scheme ultimately derive their energy almost exclusively from the radiation emitted by the sun. The way in which these energy exchanges are organized in the atmosphere provides some of the most intriguing problems confronting meteorologists.

The energy cycle may be oversimplified thus:—



Such a statement must have been written many times on thousands of blackboards, but how do the horizontal conversions in this diagram take place? What atmospheric processes are most important in this energy cycle and of what size and time scale are they? What parameters are most important in these exchanges? These are important questions with very many practical applications, and we are at last beginning to be able to answer them.

What has this to do with climatology? Climate is the average result of atmospheric processes, and we have already said that these processes derive their energy from solar radiation. But the distribution of solar radiation at the outer limit of the atmosphere is remarkably constant, the almost unchanging value of the "solar constant" being about 2 gramme-calories per cm.² per minute. Within the atmosphere the balance of radiation received and emitted is such that we can construct the following diagram (Fig. 1) which is fairly representative of the troposphere. We see from this that the only part of the earth-atmosphere system that gains heat by radiation is the earth's surface in

➤ Dr. Tucker, who is a scientist in the Climatological Research Branch of the Meteorological Office, is indebted to the Director-General of the Meteorological Office for permission to publish this paper, which was delivered as a lecture to the Annual Conference of the Association at the London School of Economics on 3rd January, 1961.

low latitudes and possibly a shallow layer of air immediately overlying these areas.* The rest of the earth's surface and practically the whole of the atmosphere lose heat by radiation; the rate of heat loss in the atmosphere would give rise to a decrease in temperature of about 1 to 2°C per day if it were not replenished by other means. The distribution of land and sea and the seasonal elevation of the sun modify this picture to some extent, but the main features remain, and the problem is to explain how the energy is transferred from the zone of increment at the surface in lower latitudes to the areas of deficit everywhere else in the atmosphere.

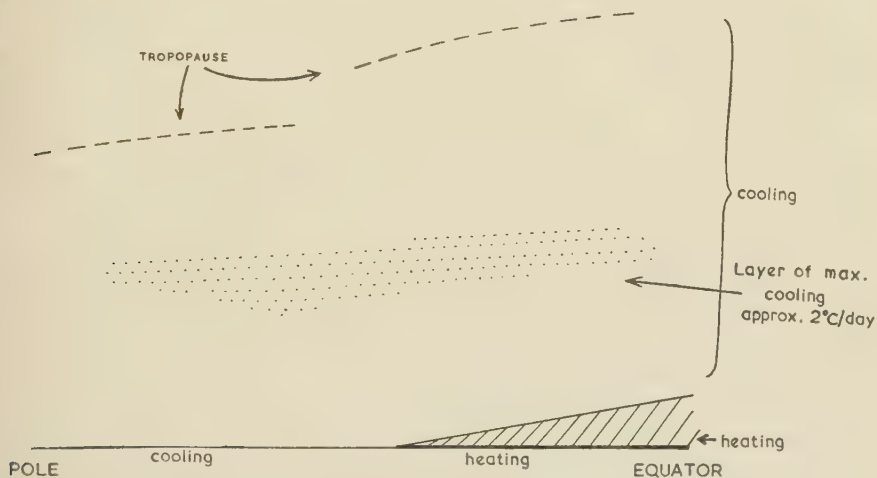


Fig. 1.—Schematic diagram showing regions of radiative heating and cooling in the atmosphere.

The energy source is constant, and the position of land and sea is constant; why then do many of the dominant features of world climate bear little apparent relation to the nature of the underlying geographical surface? For example, the existence of a mean meridional circulation and of trade winds in low latitudes, the zone of large, frequent and rapidly moving disturbances in the middle latitudes—these and many other climatic features are largely independent of surface conditions. They occur because the mechanisms of energy exchange in the atmospheric system act in a certain preferred way: they are brought about dynamically. It is the emergence of dynamical climatology, the appreciation of and investigation into the dynamics of climate that has been the major development in climatology during the last decade.

Before outlining the achievements of dynamical climatologists in the last ten years I should like to extend this point of view a little further. Even for those climates which are most obviously associated with surface

* Regions of the atmosphere above about 30 km. where direct absorption of solar energy becomes important are specifically excluded from this discussion because the mass of atmosphere involved is very small.

geography, it seems to me to be begging the question to imply that the climate is the direct result of land-sea juxtaposition. Many climatic phenomena are undoubtedly the indirect result of surface physical features; but it is the atmospheric processes that are mainly responsible for climate and we must learn how and why these phenomena occur before we can understand climate. For example, we may ask why do atmospheric processes over the Canary Islands and the Western Sahara in summer lead to a net divergence of horizontal water-vapour transport and therefore a large excess of evaporation over precipitation, whereas a few hundred miles further south over Nigeria and Sierra Leone there is a net convergence and a large excess of precipitation over evaporation? To say that this is because of the existence of the Guinea Monsoon is not answering the question but merely describing the result.

The emergence of the urgent need to explain and understand quantitatively as well as to describe and classify has characterized recent major developments in climatology. "Emerge" is probably the wrong word because the desire to understand is the driving force behind most spheres of scientific inquiry, but there has certainly been an accelerated development along these lines in the past few years. This is not to say, of course, that there has been no development in the cataloguing of climate. The rapid increase in frequency of observations in both time and space, and their accuracy, particularly as regards the upper atmosphere, has been such that progress was almost inevitable. We now have a good quantitative idea of average conditions in the northern hemisphere troposphere and also of deviations from these averages, though the southern hemisphere still suffers from the obvious lack of reporting stations over the oceans. There are even prospects of a decrease in surface ship observations because increasingly more submarines and aircraft are being used in preference to surface craft for journeys to and from the Antarctic.

Some important work has also been carried out in the location and analysis of historical records of climate. The study of climatic change has gained much from the precise cataloguing of past historic conditions.¹ But the purpose of the present paper is to review progress in the study of the dynamics of climate.

THREE TECHNIQUES OF STUDY

Dynamical climatology has been developed along three main lines, by theoretical investigation, by experimentation and by observational analysis.

Theoretical investigations often proceed in broadly the following way. A simplified form of the atmosphere is considered, and the effects of certain physical processes on this model are studied. The conditions to which these processes must conform are written down in the form of mathematical equations. The equations are then manipulated in

such a way that selected types of motion can be studied particularly as regards the possibility of their existence, maintenance and development, and the effect of their life cycle on the various parameters involved in the equations.

One of the finest papers illustrating the theoretical approach to climatology is that by Phillips which he calls "The general circulation of the atmosphere: a numerical experiment".² The model of the atmosphere and the equations used are so realistic that the flow patterns he develops include a narrow meandering current of high winds in the upper troposphere (the jet stream), zonal surface westerlies in middle latitudes and the growth of a large disturbance. The energy transformations associated with these features were studied and found to demonstrate quantitatively the important role of the disturbance in the development of zonal currents. It is well to emphasize here that investigations such as that of Phillips could not be undertaken without the aid of modern electronic computing machines.

Laboratory investigations and particularly observational analyses are essential concomitants to the theoretical approach because they describe the phenomena observed in the atmosphere which have to be explained and also suggest the lines of approach and types of motion which may be important.

Experimentation in the laboratory has been carried out mainly by means of so-called "dish-pan" experiments. A fluid is contained in a cylindrical or hemispherical vessel with a central core, and atmospheric conditions are to a greater or less extent simulated by rotating the dish-pan at various speeds and heating or cooling the central core or the perimeter. The rates of rotation and differential heating can be so varied that the motion within the fluid can become remarkably similar to that observed in the atmosphere. The motion is studied by introducing some form of tracer into the fluid. Experiments of this type have yielded much insight into the mechanisms of the general circulation particularly as regards the relative importance of convective or dynamical régimes.

It is, however, the third technique, that of observational-statistical analysis, that has contributed more than any other to our understanding of the processes that determine world climate.

OBSERVATIONAL STUDIES

Apart from the routine tabulation of average values and deviations from these averages (which by analogy one might call Static Climatology), observational studies have developed along three lines: the study of angular momentum, energy balance and water-vapour balance. Although the ideas were originated by Priestley,³ most of the work has been carried out by Starr and White.⁴ Briefly, the approach is that these three quantities are effectively constant when summed over the entire atmosphere throughout a year, but in certain

parts of the atmosphere there is a net input (a source) and in others a net output (a sink). In order to account for the relatively steady conditions observed from year to year there must be a balance between the sources and sinks and also a steady transfer of the quantity concerned from one to the other. The source and sink areas have been the subject of many investigations, as have the transfer processes necessary to maintain the balance. The mechanisms of these transfer processes have been studied in the following way.

Let S be the amount of the quantity being studied in a unit volume of air. Then the flux of this quantity across a surface of unit area is given by the product VS where V is the velocity of the air normal to the surface. If we write an over-bar to represent the mean value in time or in space, or in both, then at any instant $V = \bar{V} + V'$ and $S = \bar{S} + S'$ where the prime denotes the instantaneous deviation from the mean. Therefore

$$VS = (\bar{V} + V')(\bar{S} + S') = \bar{V}\bar{S} + \bar{V}S' + V'\bar{S} + V'S'$$

and the mean flux is given by

$$\overline{VS} = \bar{V}\bar{S} + \overline{\bar{V}S'} + \overline{V'\bar{S}} + \overline{V'S'}$$

Now the mean value is defined such that $\bar{S}' = 0 = \bar{V}'$ and hence $\overline{\bar{V}S'} = \bar{V}\bar{S}' = 0$ and $\overline{V'\bar{S}} = \bar{V}'\bar{S} = 0$. The mean flux is therefore given by

$$\overline{VS} = \bar{V}\bar{S} + \overline{V'S'}$$

Total flux = Advective flux + Eddy flux.

The advective flux is due to the mean motion and the eddy flux depends on the correlation between V and S when they fluctuate about their mean values.

Most of the earlier work during the last decade was involved in studying the meridional flux between latitude zones. More recently studies have been applied to geographic areas, but I shall restrict my remarks mainly to the studies of meridional flux because these serve to illustrate the ideas and techniques that have been developed.

(a) *Balance of angular momentum*

The surface wind circulation over the earth is observed to consist of easterlies in low latitudes and westerlies in middle latitudes. The effect of surface friction is such as to tend to retard the surface winds thereby creating a *source* of westerly angular momentum in low latitudes and a *sink* of westerly angular momentum in middle latitudes. (These sources and sinks are supplemented by a contribution due to the pressure differences across mountains.) The effect of this surface drag would be to destroy both circulations in a matter of days unless there were some momentum interchange between the two regimes. Now the earth-atmosphere system does not change its angular momentum significantly from year to year, and therefore a balance between source and sink

areas can only occur by a steady transfer of westerly angular momentum from one to the other.

Sources and sinks of angular momentum in the atmosphere have been studied in some detail, and the meridional transfer required to

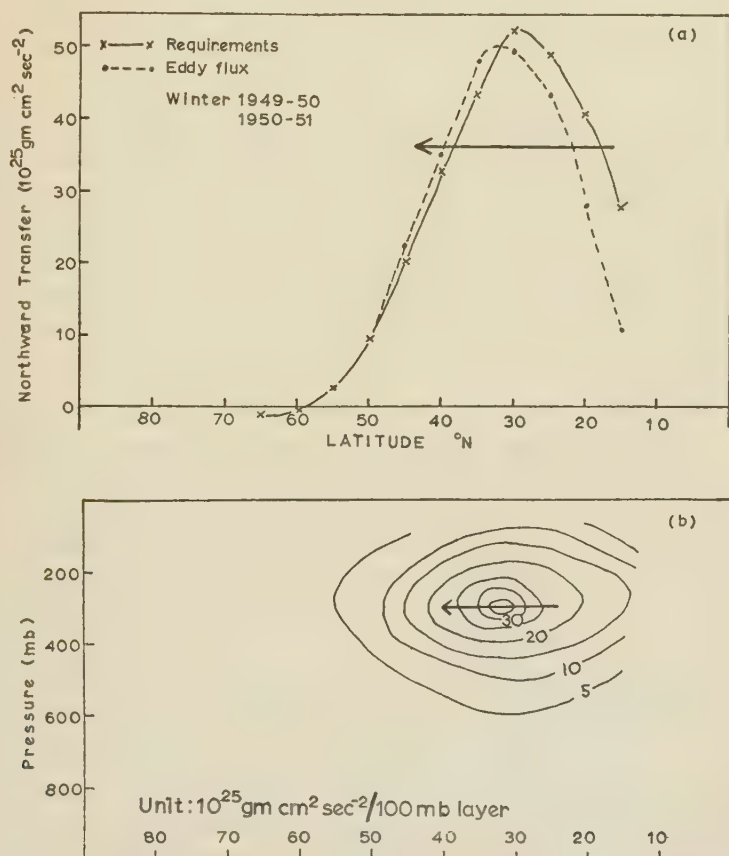


Fig. 2.—Angular momentum transfer in the atmosphere:⁶ (a) Balance requirements and deduced eddy flux. (b) Vertical distribution of eddy flux.

balance these are represented in Figs. 2a and 2b. These figures show that the difference between the transport requirements and the eddy flux becomes large south of about 30°N , and therefore the advective flux (due to the existence of a mean meridional circulation) is important only in low latitudes, most of the transfer elsewhere is brought about by the eddy flux ($\bar{V}'U'$) which is most important in the upper troposphere and is due to a correlation between the meridional velocity component, V' , and the zonal velocity component, U' .

It is interesting to elaborate a little here to illustrate the way in which these studies uncover the structure of atmospheric systems. It

was noted early in these studies that a flow pattern capable of bringing about the desired northward transfer could be of the form



where a southerly component was associated with strong westerly winds and a northerly component with weak westerly (or easterly) winds. At about this time the theoreticians⁶ showed that developing atmospheric systems were indeed associated with trough lines of this southwest-northeast orientation. And the basic notion, earlier suggested by Rossby, that atmospheric disturbances were of fundamental importance in the maintenance of the general circulation,⁷ was firmly established.

(b) *Energy balance*

The earth-atmosphere system is in radiative equilibrium with the space surrounding it; that is, it absorbs as much energy from short wave solar radiation as it emits by long wave atmospheric radiation. (In this connection the amount of energy (heat) transferred to the earth's interior (by conduction) is negligible.) However, although the system as a whole is in radiative equilibrium, we have seen from Fig. 1 that part of the system gains energy from radiation and by far the largest volume loses energy from radiation. The energy loss is called radiative cooling, and appears to attain a maximum in the middle and upper troposphere of about 2°C per day. Now although there are large-scale trends in climate, the atmosphere over the period of a year can be considered as in a steady state. That is, although the surface in the tropics is continually being supplied with energy (initially in the form of heat), there is no net gain in temperature. Similarly there is no overall decrease in temperature elsewhere in the atmosphere. Energy must therefore be transported from low latitudes and low levels to high latitudes and high levels. The amount of heat transferred horizontally by radiation and conduction is trivial and therefore the required energy transfer must occur by convection. (The meteorologist's term for convection in a horizontal plane is advection.) The way in which the wind systems are organized such as to carry out this transfer is fundamental to climatology because this dictates climate.

The picture is, however, further complicated by energy transformations. The atmosphere generally acts in such a way that potential energy is continually being converted into kinetic energy. The energy gained from the sun is being used to maintain the potential energy against this dissipation and also against poleward potential energy transfer; at the same time the level of temperature is maintained against

the dissipation due to poleward heat transfer and the energy used in evaporating water from the surface into the atmosphere. (The excess of water evaporated into the atmosphere over water precipitated maintains the level of humidity against any net transfer of water vapour out of the region.) The total poleward energy transfer required of the general circulation is therefore accomplished mainly by the transport

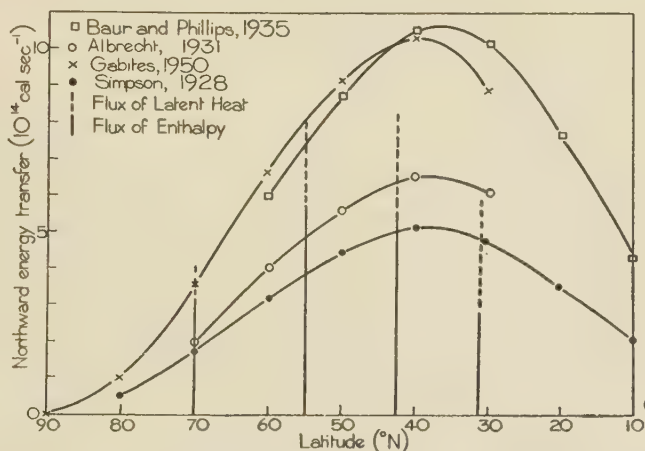


Fig. 3.—Energy transfer in the atmosphere. The continuous curves represent estimates of the northward energy transport required for balance; the vertical lines represent mean values around latitude circles of the eddy flux of energy in the form of sensible heat (enthalpy) and latent heat. The eddy fluxes were computed for the year 1950 (see reference 4).

of three energy forms: (a) potential energy, (b) sensible heat, (c) latent heat of water vapour. Kinetic energy is also capable of being transferred but this flux can be shown to be very small compared with the other fluxes which have been intensively studied in the past decade. The contribution of ocean currents to the transfer of energy is also probably important but is one aspect of this work that has been relatively neglected.

Some of the main results of energy balance studies are given in Fig. 3. The curves summarize some of the calculations of the meridional energy transports needed to balance estimated gains and losses of energy by radiation. The differences between the curves illustrate the unfortunately large measure of uncertainty with which the modern climatologist has to work; but broadly speaking the more recent estimates can be considered much more reliable than the earlier ones, and all agree that the maximum transport should occur between 30° and 40°. The eddy transports computed by Starr and White show that a considerable portion of the required transport is brought about by eddies (disturbances) in middle and high latitudes, and that the energy transferred in sensible heat and latent heat forms is comparable. In lower latitudes the mean meridional circulation seems to be important as in the case of angular momentum.

Figures 4a and 4b show the vertical distribution of the horizontal transports of sensible heat and latent heat, and enable comparisons to be made of the two forms of energy transported. For the period considered over North America, most sensible heat was transported in

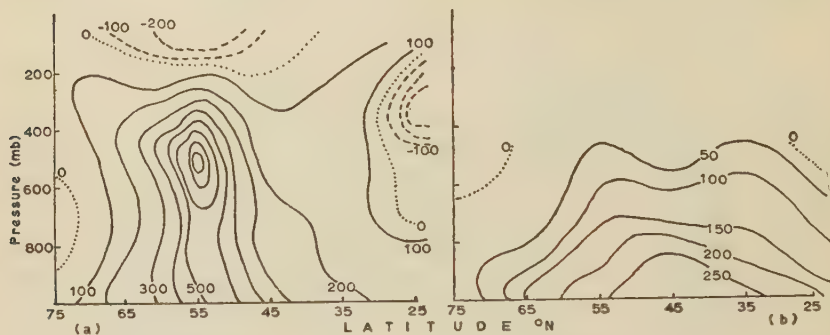


Fig. 4.—Mean eddy transfer of (a) sensible heat and (b) latent heat over North America during February 1949.⁸ Units are in $\text{cal./sec.} \times 10^7/\text{deg. longitude/mb. layer}$. Reproduced by kind permission of the Editor, *Quart. Journ. Roy. Met. Soc.*

the middle troposphere between 45°N and 65°N , whereas the latent energy transport (due to the northward flux of water vapour) occurred over a broader latitude zone but was confined to the lower troposphere because the atmosphere contains relatively little water vapour above about the 400 millibar (7 km.) level.

(c) *Water balance*

The amount of water lost to space and to the earth's interior is very small, and we can also regard the amount of water contained within the oceans as relatively constant over any long period of time. Therefore within the atmosphere there must be an overall water balance as well as an angular momentum balance and an energy balance. The source regions are areas where evaporation exceeds precipitation, and the sink regions where the reverse is true. Until fairly recently, studies of water vapour transfer on a global scale were also largely confined to studies of the overall balance between different latitude zones. However, water vapour is not so suitable a parameter as energy and momentum for this type of analysis; this is not only because evaporation-precipitation differences cannot yet be evaluated very accurately on a climatological basis, but also because the sources and sinks of water vapour are not as markedly dependent upon latitude as are those of energy and momentum.

Perhaps one of the most interesting results of these analyses is that of Starr and Peixoto in a paper called "On the global balance of water vapour and the hydrology of deserts".⁹ They obtain strong maxima of divergence of water vapour transport not only over certain oceanic

areas but also over three separate arid regions. This implies an unexpectedly large excess of evaporation over precipitation over these deserts which must be balanced by a convergence of liquid water on or below the surface.

CONCLUSIONS

I have attempted here to summarize what may well be a major development in climatology which has emerged during the last ten years or so. In doing this, I have briefly described some of the more important techniques used in the observational branch of dynamical climatology and have stated one or two of the more interesting results. Apart from the one example in the water balance studies, I have not attempted to deal with the very recent attempts to apply the flux techniques to geographic areas on the scale of the North Atlantic Ocean. However, currently in the Climatological Research branch of the Meteorological Office we are applying these methods to such "local" studies, and preliminary results are most encouraging. In this respect it must be mentioned that a month is obviously only a convenient time interval and has no special climatological significance. Mean monthly patterns of any quantity may therefore completely mask any physical processes which act partly in one month and overlap into the next. For this reason flux convergence studies will probably be used to investigate persistent synoptic patterns and anomalous climatological phenomena (like the summer of 1959 over the United Kingdom) where the time scale is not dictated by the calendar.

REFERENCES

- ¹ H. H. Lamb and A. I. Johnson, "Climatic variation and observed changes in the general circulation", *Geografiska Annaler*, vol. xli, 1959, pp. 94-134.
- ² N. A. Phillips, "The general circulation of the atmosphere: a numerical experiment", *Quart. Journ. Roy. Met. Soc.*, vol. 82, 1956, pp. 123-64.
- ³ C. H. B. Priestley, "Heat transport and zonal stress between latitudes", *Quart. Journ. Roy. Met. Soc.*, vol. 75, 1949, pp. 28-40.
- ⁴ Summarized in V. P. Starr and R. M. White, "Balance requirements of the general circulation", Cambridge (Mass.) Institute of Technology, Dept. of Meteorology, General Circulation Project, Contract no. AF 19-122-153, *Final Report*, part 1, 1954, pp. 186-242.
- ⁵ G. B. Tucker, "The atmospheric budget of angular momentum", *Tellus*, vol. xii, 1960, pp. 134-44.
- ⁶ E. T. Eady and J. S. Sawyer, "Reviews of modern meteorology. 3, Dynamics of flow patterns in extra-tropical regions", *Quart. Journ. Roy. Met. Soc.*, vol. 77, 1951, pp. 531-51.
- ⁷ C. G. Rossby, "On the nature of the general circulation of the lower atmosphere", chapter 2 of *The Atmosphere of the Earth and Planets*, G. P. Kuiper (ed.), Chicago Univ. Press, 1948, pp. 16-48.
- ⁸ These diagrams appeared originally in R. M. White, "The meridional eddy flux of energy", *Quart. Journ. Roy. Met. Soc.*, vol. 77, 1951, pp. 188-99.
- ⁹ V. P. Starr and J. P. Peixoto, "On the global balance of water vapour and the hydrology of deserts", *Tellus*, vol. x, 1958, pp. 188-94.

Atmospheric Circulation, Climate and Climatic Variations

H. H. LAMB

THE CLIMATE OF ANY PLACE is determined by:

- (i) *radiation conditions*, including the time distribution of radiation gain and loss; these are controlled by the latitudinal position, the altitude above sea level (because this affects the quantities of solar and terrestrial radiation transmitted through the atmosphere), the slope of the land surface towards or away from the solar beam and the nature of the surface as it affects absorption and reflection of radiation; and
- (ii) *the atmospheric circulation*, transporting heat in both its sensible and latent forms, moisture (both as invisible vapour and in its condensed forms as fog, clouds, rain and snow etc.), solid matter carried up from the surface (dust, sand, sea-salt, smoke particles, ice grains etc.) and various liquid or gaseous forms of pollution. Atmospheric circulation processes involving vertical motion (and therefore adiabatic cooling) are responsible for most of the clouds and weather, thunderstorms, showers and long continued gentler rains, which correspond respectively to different types of vertical motion. The atmospheric constituents named also partly screen, scatter or reflect back some of the incoming solar and outgoing terrestrial radiation.

The atmospheric circulation is therefore the fundamental mechanism of climate. And even in the Sahara, the Australian desert and the central regions of the Antarctic ice cap one year differs from another because the atmospheric circulation gives rise to events which interfere with the heat balance, which the regular astronomical and geometrical controls of the radiation climate would otherwise produce.

The atmosphere is set in motion by the unequal heating of different latitudes and different types of surface, causing vertical expansion (lifting of the upper atmosphere) over the warm regions and vertical contraction of the air columns over the cold regions. Thus, even if we could suppose the air initially at rest, and pressure uniform everywhere at sea level, pressure gradients from the warm to the cold zones would be bound to exist aloft and a circulation tendency would be introduced.

► Mr. Lamb is a member of the scientific staff of the Climatological Research Division, Meteorological Office, Bracknell, at present in charge of a group studying the variations of climates. He is indebted to the Director General of the Meteorological Office for permission to publish this paper which is based on a lecture delivered to the Annual Conference of the Association at the London School of Economics on 3rd January, 1961. Acknowledgment is made to the Editor of the *Meteorological Magazine* for the loan of blocks for Figs. 1-4.

Figure 1 shows the distribution of net radiation received (i.e. the balance of incoming solar less outgoing terrestrial radiation) in January and July by latitude. On a longer term balance, of course, the overall picture is that the earth plus atmosphere loses as much heat as it gains, apart from the very slight unbalance represented by any changes in the heat stored mainly in the oceans and coming to light as a climate change. World maps of net radiation¹ leave no doubt that, in spite of some complexities attributable to geography and to the atmospheric circulation itself, the distribution of effective heating is mainly controlled by latitude and season. The curves in Fig. 1 show that the main gradients in both hemispheres are generally in middle latitudes;

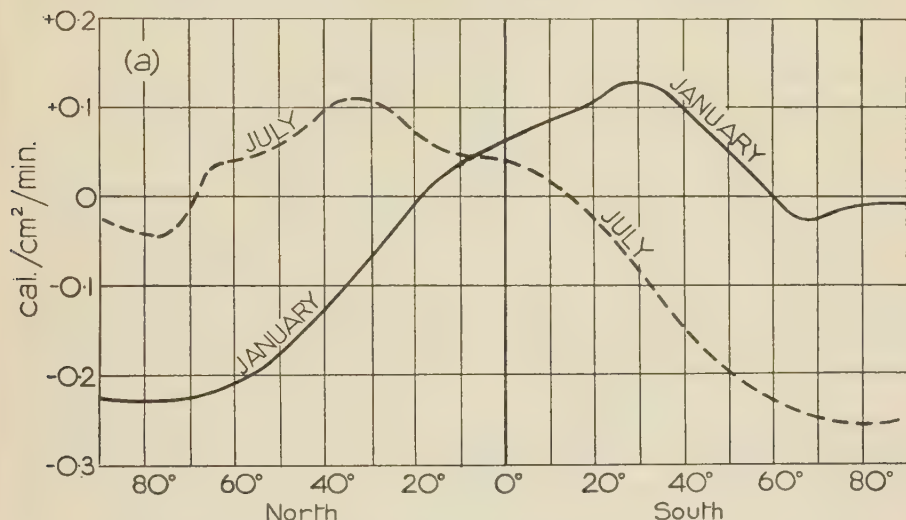


Fig. 1.—Latitudinal distribution of intensity of net radiation received (after Simpson: the January curve should dip rather lower than shown between 65 and 90°S, since the albedo of the Antarctic ice sheet in summer is now known to be greater than Simpson assumed). (Reproduced by courtesy of the Controller of Her Majesty's Stationery Office.) (Original in *Met. Mag.*, Dec. 1958, p. 368.)

the over-all differences of effective heating are much less in summer than in winter, though a zone of locally very strong gradient exists near 70°N in summer where the strongly heated land surfaces abut upon the Arctic ocean with its pack-ice.

Figure 2 gives the average picture for the year of the pressure differences arising in the upper atmosphere at about the 5-kilometre level over the northern and southern hemispheres, the lines being contour heights of the 500-millibar pressure level. The striking feature here is the fundamentally simple planetary pattern of the pressure field, corresponding well with the basic heating distribution—a far simpler pattern than that presented by the rather many anticyclones and depressions of the surface pressure map.

The air's motion is controlled by a balance of forces due to pressure differences, the rotation of the earth, the curvature of the air trajectories

and friction. The result is that in general, except near the equator, the wind blows nearly along the lines of equal pressure (isobars and contours of a constant pressure surface) and these lines may be used as a convenient way of mapping the prevailing winds. The wind blows counter-clockwise round regions of low pressure in the northern hemisphere and clockwise in the southern hemisphere. The steepness of the pressure gradient, or of the gradient of a constant pressure surface (as in Fig. 2), gives an indication of the strength of the winds; though this also depends on the latitude and path curvature amongst other things.

From this it will be understood that Fig. 2 reveals the pattern of the mean upper wind flow at about the 5-kilometre level as consisting largely of a single great whirl (or "vortex") of westerly winds over either hemisphere. The winds are strongest where the gradients are strongest, generally in middle latitudes or where the general gradients of effective heating at the surface are particularly strong. Ice limits and land-sea contrasts affect the detailed positions, and the differences between the circulation over the northern and southern hemispheres are interesting in this connection.² Thus we observe that the upper air circulation is rather simply related to the large-scale features of the temperature field of the surface and of the lower atmosphere. (This might at first sight be regarded as a paradox, though the physical reasons are straightforward.) And this upper wind distribution contains the basic steering currents of the atmospheric circulation, since the flow pattern is broadly similar from heights of about 2 to 5 up to 15 to 20 kilometres, involving 70 per cent or more of the mass and most of the momentum of the atmosphere—cf. the vertical cross-section diagrams, Figs. 3 and 4.³

There are more or less prominent waves (meanderings) in the course of the upper westerlies, most pronounced in the northern hemisphere (Fig. 2). These waves are apparently determined partly by the geography of relatively warm and cold surfaces in different parts of each latitude zone and partly by the dynamics of a current in a fluid disturbed either by injection of heat or by passing over mountain barriers. The great north-south (meridional) mountain chains of the Rockies and the Andes and the high plateaux of Asia are particularly important in giving rise to preferred longitudes for ridges and troughs in the contours of the pressure surfaces aloft and corresponding wave-like meanderings in the upper westerly winds. The spacing and positions of these ridges and troughs (and the relatively warm and cold regions respectively which accompany them in each latitude zone) change with the prevailing strength of the windstream and as the belt of strongest winds shifts to different latitudes north and south, for example with the changing seasons.

The broad, deep current of westerly winds which dominates so much of the atmosphere over both hemispheres is concentrated in certain

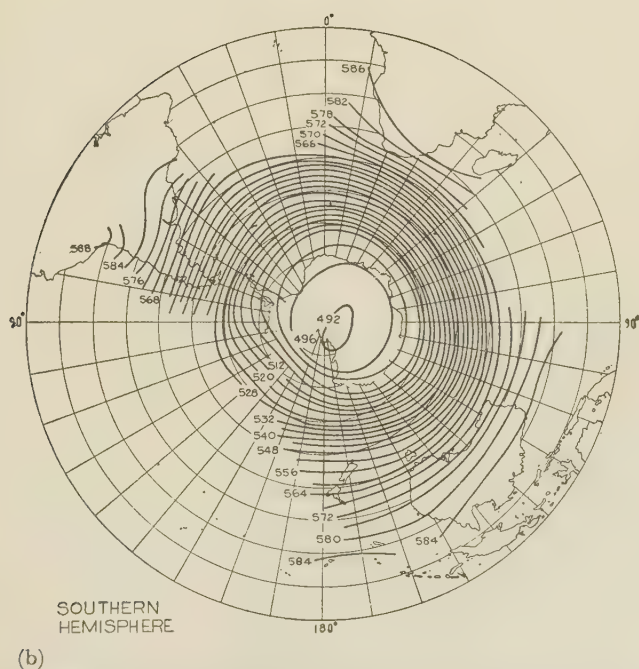
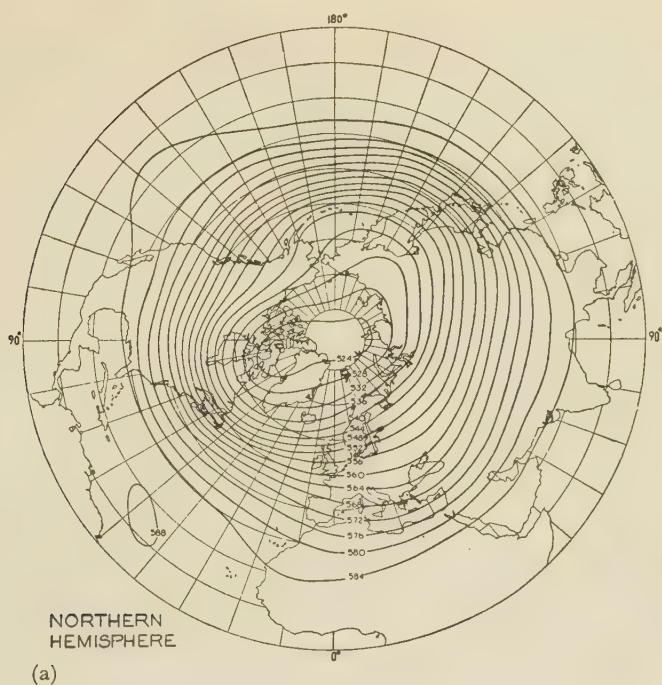


Fig. 2.—Mean height in dekametres of the 500-millibar pressure level. (a) northern, (b) southern hemisphere. (Reproduced by courtesy of the Controller of Her Majesty's Stationery Office.) (Original in *Met. Mag.*, Dec. 1958, p. 371.)

belts into what are called "jet streams" with maximum wind speeds of 100 to 200 knots or more. There is a general level of maximum wind near, or just below, the tropopause—the dividing surface between the lower atmosphere (troposphere) and the stratosphere with its independent heat source (ozone which directly absorbs solar radiation of certain wave-lengths) and consequently independent heating pattern. The level of maximum winds is where the thermal gradients in the lower atmosphere (as at the ice margin and near the very mobile polar fronts) produce their greatest integrated effects.

Adjustments in the flow of the upper winds, particularly where subjected to strong accelerations and retardations on entering and leaving the jet streams, produce accumulations and divergences of mass which account for the anticyclones and depressions of the surface weather map and steer, or propagate, them generally from west to east around the world. High pressure systems predominate along the warm flank (equatorial side) of the polar front jet streams which give the strongest flow at the 5-km. level (Fig. 2) and the subpolar low pressure regions in either hemisphere are dynamically produced at the cold side of the jet streams. A reverse distribution with high pressure to the poleward side and low pressure on the equatorial side tends to appear at the surface over more restricted regions in the neighbourhood of the confluence to a strong stream aloft. In this way the main features of the prevailing pattern of pressure and winds at sea level may be explained, most particularly the sub-tropical high pressure and sub-polar low pressure belts with the cell divisions to which each is subject. These are the features displayed on the average pressure and wind maps in any physical atlas; a rather fuller discussion of their causation is available in a textbook by Willett and Sanders⁴ and in a recent paper by the author.⁵ More advanced treatments are given in numerous papers in the scientific and technical journals, one of the most lucid being an early essay by Rossby dating from 1941.⁶

The long spells of more or less abnormal weather which mark the character of particular seasons are associated with more or less pronounced displacements of the main windstreams aloft and at the surface. They are accompanied by corresponding extensive and persistent anomalies in the temperature field at the surface and in the lower atmosphere. In some cases anomalies in the thermal condition of the surface (e.g. extensive warm or cold ocean layers), such that enormous quantities of heat (and a long time) would be required to change them, may be responsible for these shifts in the circulation and climatic pattern; at other times the anomalies may be brought about by some general strengthening or weakening of the circulation, the causes of which are not yet sufficiently understood.

The independent circulation generated in the ozone layer in the stratosphere (at heights of 20 to 50 kilometres approximately) involves directly or indirectly about 10 per cent of the mass of the atmosphere.

Over that hemisphere where it is winter we observe again at these heights a circumpolar vortex of westerly winds. The most striking difference from the lower atmosphere is over the hemisphere where it is summer (southern hemisphere in Fig. 3). The lower atmosphere over the polar regions is kept cold in summer by the wastage of heat through radiation reflected away by the polar ice caps, and hence the main tropospheric wind circulation consists of upper westerlies circulating around a cold polar core—as in winter, though much weaker. At higher levels, in the stratosphere, we find easterly winds circulating around a warm polar core in summer. This is partly because the 24-hour polar day actually brings in more radiation than is available at any other latitude around the summer solstice, and partly because of heat transport and dynamic effects produced by the meridional (north-south) components of the circulation in the stratosphere.

The mean vertical and meridional components of the general circulation are very much weaker than the mean zonal circulation, but the vertical motion is of course intimately linked with the prevailing cloud types and weather. Thus we find mean descending currents over the arid zones and upward motion in the zones of equatorial and polar front rains. Even the monsoons⁷ must be interpreted in relation to the positions and dynamics of the main airstreams; the details cannot be gone into within the compass of a short article and naturally do not appear on a cross-section in the Atlantic sector.

An atmospheric cross-section shows a structure of twin vertical and meridional circulations repeating similar features in both the summer and winter hemispheres; only the latitudinal positions and the strengths differ somewhat as between summer and winter and northern and southern hemispheres. Yet in the Atlantic sector the net circulation of the ocean is one, the surface layers moving ultimately from the Antarctic or sub-Antarctic (probably by way of several circuits of the anticyclonic regions of the South and North Atlantic) right through to the Arctic. The compensating return current is lower down in the deep ocean. This is commonly attributed to the geographical accident that the Equatorial Current of warm surface water circulating around the South Atlantic anticyclone is divided by the “nose” of Brazil near 5°S; some of this surface water is lost to the South Atlantic and makes its way to the Caribbean and thence into the Gulf Stream. Obviously this is a very sensitive point in the ocean circulation, since a slight southward shift of the ocean current systems (and of the atmospheric circulation systems driving them) would affect the quantity of warm water “splitting off” from the Equatorial Current at the coast of Brazil and indirectly, therefore, the warm water supply to the Gulf Stream.

The surface waters of the North Atlantic are also likely to be much more affected than those of other oceans by changes in the quantity of ice produced on the polar seas, since the region between northeast

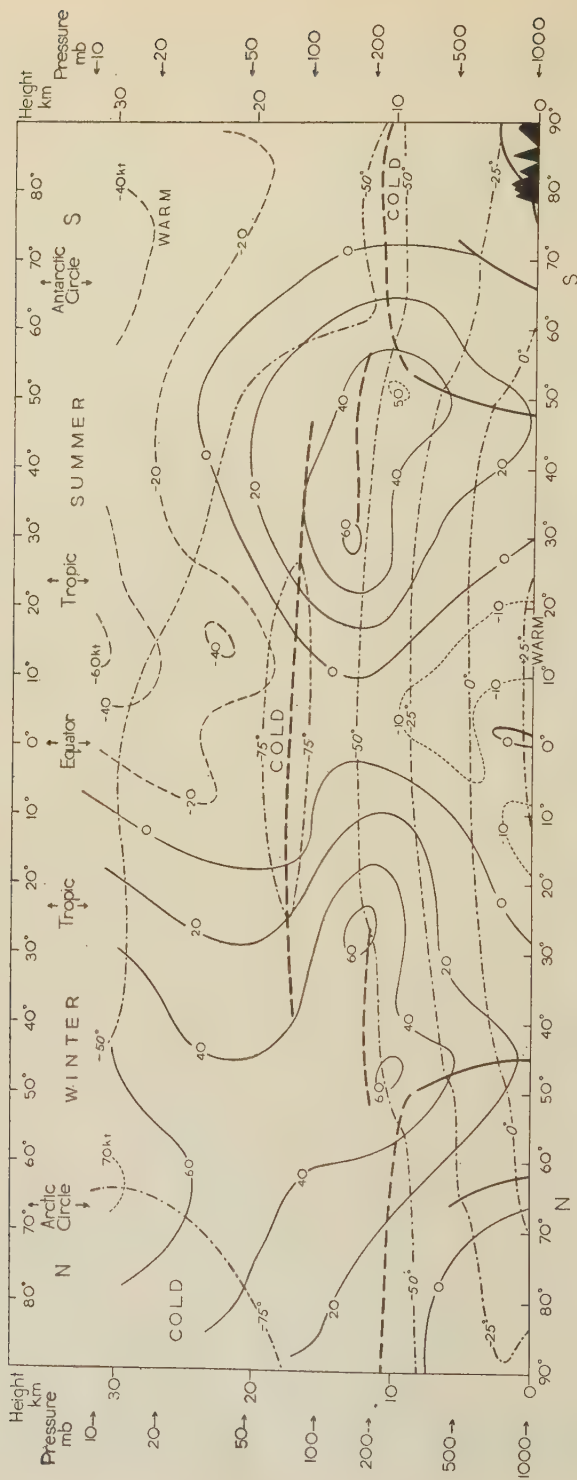


Fig. 3.—Cross-section showing isopleths of mean west wind speed (knots) and dry bulb temperature ($^{\circ}\text{C}$) near 30°W in January. (Reproduced by courtesy of the Controller of Her Majesty's Stationery Office.) (Original in *Met. Mag.*, Dec. 1960, facing p. 321.)

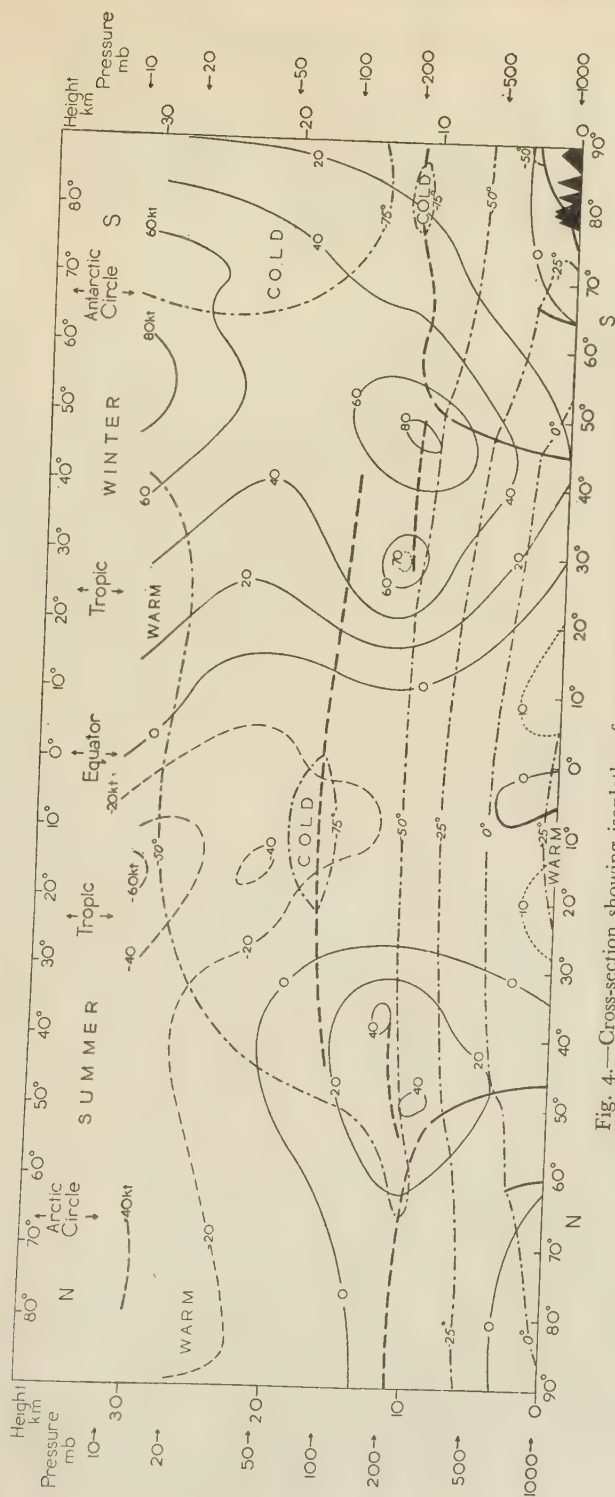


Fig. 4.—Cross-section showing isopleths of mean west wind speed (knots) and dry bulb temperature ($^{\circ}\text{C}$) near 30°W in July. (Reproduced by courtesy of the Controller of Her Majesty's Stationery Office.) (Original in *Met. Mag.*, Dec. 1960, p. 321.)

Greenland and Spitsbergen and Franz Josef's Land is the only effective outlet for Arctic ice.

Possible causes of climatic change

We are now in a position to consider how changes of climate might come about. The possible causes may be grouped under the following heads:

- (i) *Astronomical variations*
- (ii) *Solar variations*
- (iii) *Terrestrial changes*
- (iv) Variations in the cloud albedo (reflectivity), turbidity/transparency, composition and heat content of the *atmosphere*
- (v) Variations in the heat content, ice cover and circulation of the *oceans*. (Submarine geographical changes affecting the ocean currents can also be considered under (iii).)

The astronomical changes to be considered are mainly periodic orbital changes affecting the range of the seasons in the earth's course around the sun, the periods being counted in tens of thousands of years. There is no certain knowledge so far of any solar variations of importance. It is commonly supposed that our sun has undergone variations over periods counted in millions of years. Variations of solar output of a more regular character in the course of the 11-year, 22-year and longer sun-spot cycles have also been suggested but not demonstrated—only changes in the ultra-violet wavelengths affecting a small fraction of 1 per cent of the incoming solar energy have been shown to occur during these solar cycles. (It may be presumed that these variations produce some changes in the ozone layer of the stratosphere.)

Under terrestrial changes we consider changes in the geography of the earth which must certainly produce important climatic differences on the geological time scale—e.g. changes in the positions of the poles (and equator) and of the relative positions of the continents, changes in the extent of land and sea, changes in the main orography and in the submarine ridges. Some of these factors must radically alter the pattern of heating and cooling of the atmosphere and the strength of the thermal gradients arising. The distribution of mountain ranges affects the flow of the atmosphere, its general strength and the longitudes where warm ridges and cold troughs are most frequent in the temperate and higher latitudes. The geography of submarine ridges, as of surface channels, affects the flow and heat transport of the oceans. In this connection, changes in world sea level resulting from the (formation and) melting of the great inland ice sheets and glaciers of the Quaternary ice ages may be important in (cutting off and) opening up access of ocean currents between the Arctic and lower latitudes.

Here we begin to meet changes over periods measured in thousands of years or less which must certainly have (or have had) climatic consequences. Volcanic uplift and erosion caused by various agencies

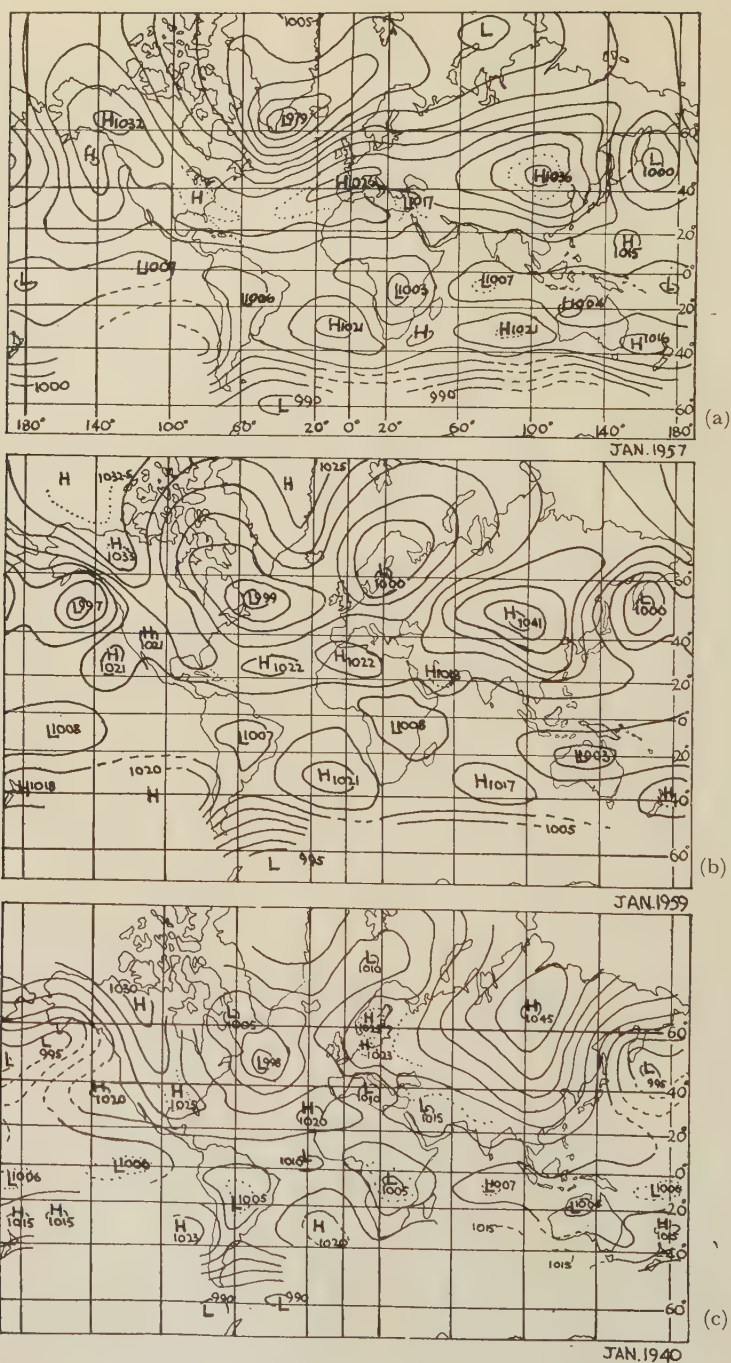
are continually modifying the geography of the earth. Examination of geographical, botanical, zoological and historical (documentary) evidence, however, leads us to consider also the occurrence of climatic changes over still shorter time-scales. Indeed climatic changes may be substantiated even within the period since meteorological instruments were invented and first came into general use (from about A.D. 1700 onwards). Some real changes have occurred even within the impressions and experience of most people now living: for the last hundred years or so have seen an important warming up of much of the world—the over-all average rise of world (surface) temperature since 1850 is about 1°C and figures for high northern latitudes are materially greater than this. The change led to a period of about forty years (1896 to 1937) with only two severe winters in Britain and to two decades (the 1930s and 1940s) of summer weather and temperatures in this country apparently unmatched for several centuries before. Since 1950 (earlier in the case of the winters) it has appeared doubtful whether the warming trend is continuing, and latterly a new downward trend (e.g. slight increases in the Arctic ice) has been reported in most sectors of the northern hemisphere.

For the causes of these shorter-term climatic variations it seems most profitable to consider the observed and measurable changes in various constituents of the earth-ocean-atmosphere system—e.g. changes in the albedo (reflectivity) of the surface accompanying changes of vegetation and land use, changes brought about by the slow heat transport of the deep ocean, changes due to varying amounts of volcanic dust (and other solid particles) occurring as veils in the stratosphere and the increased quantity of carbon dioxide (which absorbs and returns some of the outgoing terrestrial radiation) in the atmosphere with the ever-increasing burning of fossil fuels in the industrial era. The carbon dioxide changes obviously cannot account for various decades and longer periods of climatic cooling in historical and recent times, but in all these cases we are concerned with a balance of effects from a number of influences all of which are varying somewhat.

Evidence of climatic changes

All the meteorological elements affected (temperature, rainfall, prevailing winds, frequencies of storms, fog, frost etc.) afford evidence of the variations from year to year, decade to decade and century to century, which are always going on.⁸ Statistical criteria are useful in assessing which variations are important.

Average maps of atmospheric pressure (reduced to mean sea level) and prevailing winds, similar to those in physical atlases, but referring to different individual months or to the same month over different groups of years, enable us to follow the circulation changes involved in the climatic variations with which we are concerned. Figures 5a, b and c illustrate three different types of mean pressure map for January 1957,



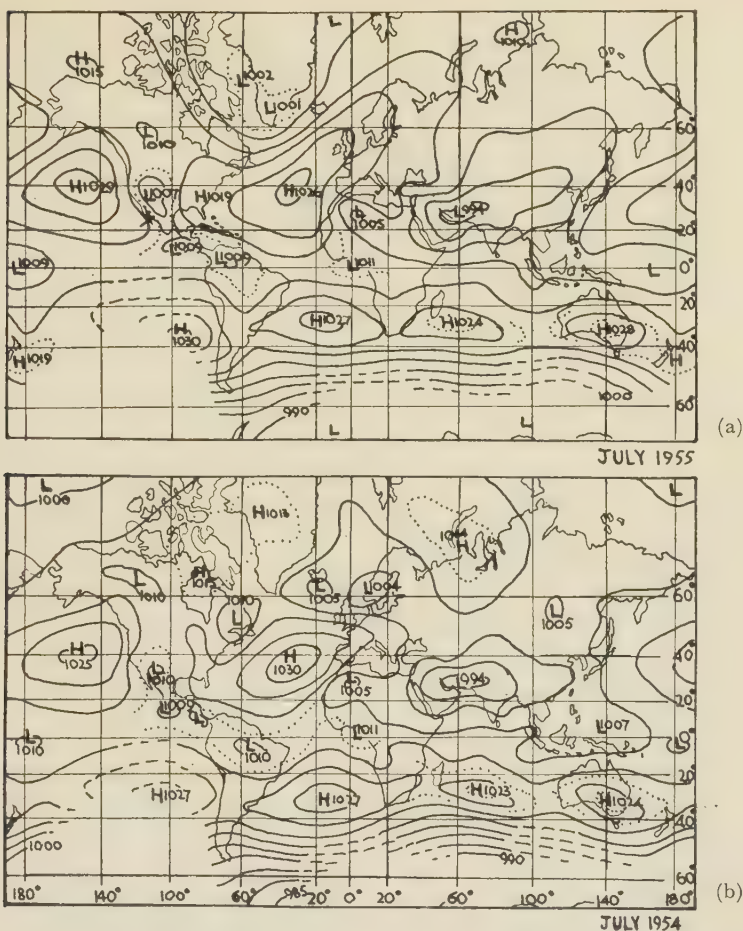


Fig. 6.—Average pressure (reduced to mean sea level) for July (a) 1955, (b) 1954.

1959 and 1940, giving respectively prevailing southwesterly, northerly and easterly winds in Britain (i.e. respectively the commonest pattern for mild and two different patterns for cold winter weather). Figures 6a and b illustrate the patterns of a fine and a wet July in this country (1955 and 1954 respectively).

The changing frequencies of situations more or less resembling these have determined variations of climate in recent decades and centuries. Figures 7a and b illustrate the result in terms of the 40-year average pressure distribution for January in two epochs, 1900–1939 and 1790–1829, for comparison. The time around 1800 was one of more frequent continental air and cold winter weather over Britain and of rather weaker general atmospheric circulation than in the more recent period.

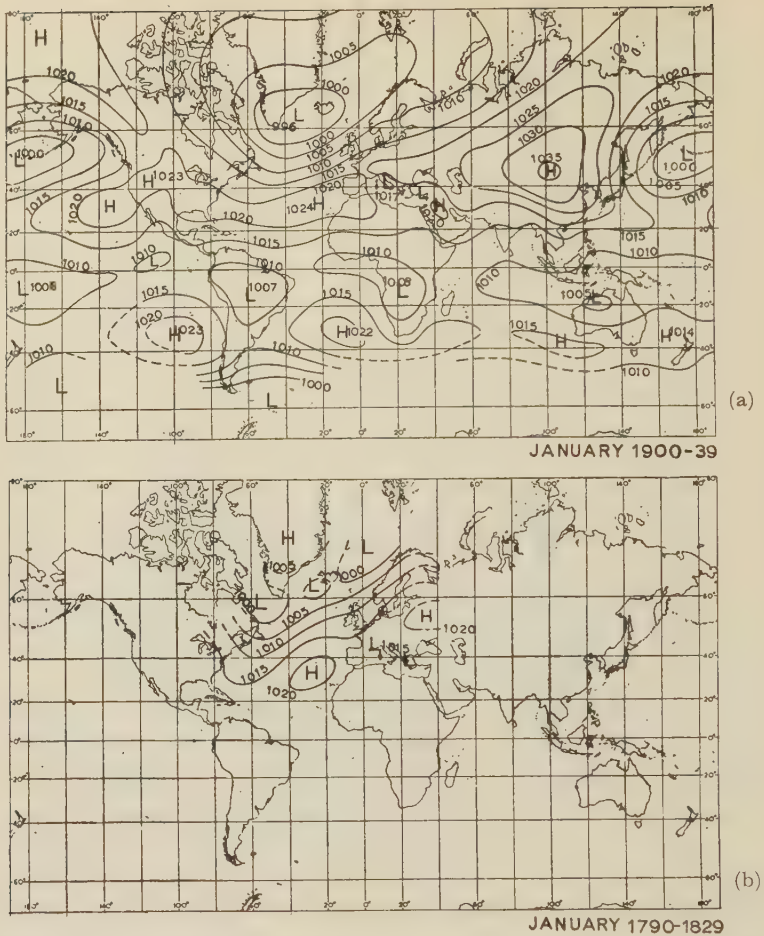


Fig. 7.—40-year average mean sea level pressure for January (a) 1900-1939, (b) 1790-1829.

The change of circulation vigour apparently amounted to several per cent, a sufficient magnitude to suggest that it ought to be possible to identify some important physical cause. One plausible suggestion which has been favoured by many authors is that the volcanic eruptions which appear to have been abnormally frequent in many parts of the world, at least in the northern hemisphere, between about A.D. 1500 and 1900 maintained for much of the time dust veils in the high atmosphere sufficient to cut down the solar radiation available at the surface. This would allow the formation of more extensive ice and snowfields in high latitudes, which in turn reflect away and waste more of the solar radiation. A dust veil thrown up to a height of about 30 kilometres by one great eruption would largely stay suspended in the stratosphere for 2 to 3 years, and might tend to gather increasingly over polar latitudes, owing to the apparent nature of the meridional

circulation in the stratosphere. The effects of additional thickness and extent of polar ice formed during this time would probably take still longer to dissipate. Some measurements and numerical estimates

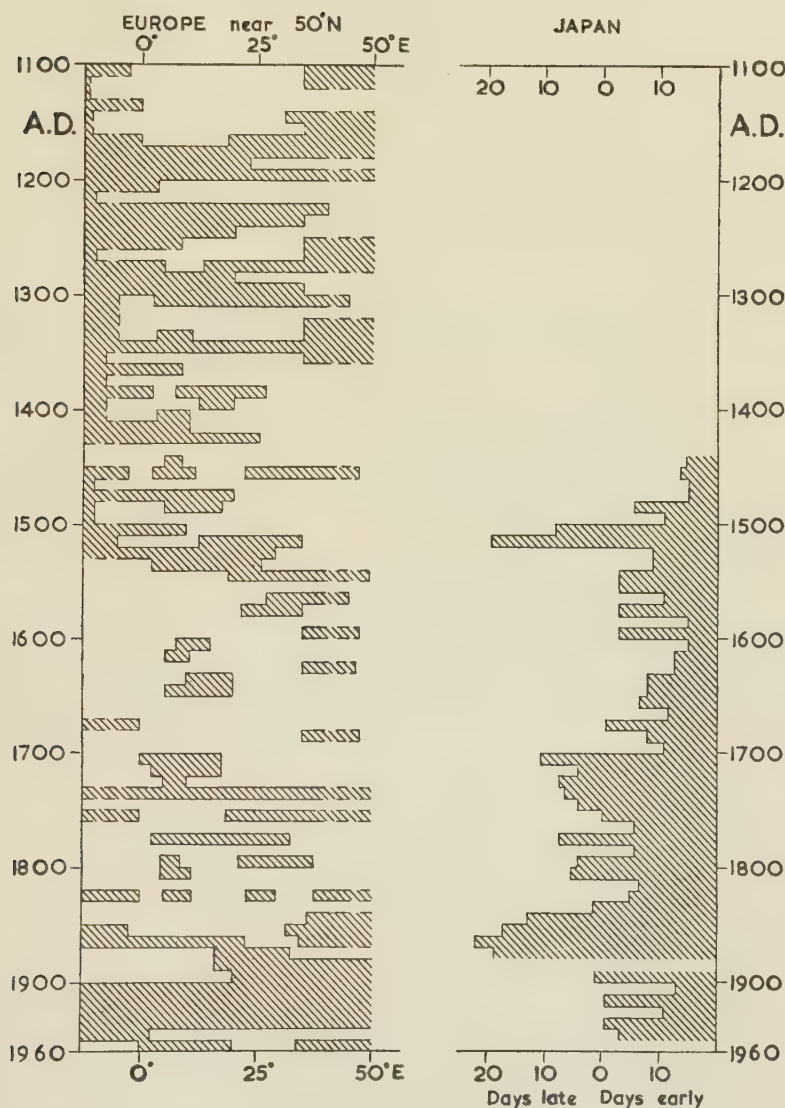


Fig. 8.—Winter severity in Europe and Japan: a survey of historical weather records by decades from A.D. 1100 to 1959. (a) Europe: hatched areas indicate decades with an excess of obviously mild, white areas decades with an excess of obviously cold winter months (Decembers, Januarys and Februarys only) in different European longitudes near 50°N. (b) Japan: the average freezing dates for each decade since 1440 of a small lake in central Japan (36°N 138°E). Hatching is used to indicate prevalence of mild weather, which in Japan is associated with oceanic air originating in the Pacific anticyclone farther east. A broken outline is used to indicate uncertain details. Note that data on Lake Suwa, Japan, are missing for the 1880s.

already available appear to support this proposition regarding the role of volcanic dust, but much further investigation is required.

Figure 8 shows schematically the outcome of a preliminary survey of documentary evidence of the character of the winters in different European longitudes from A.D. 1100 to the present day. This shows periods of prevalence of mild winter weather in most parts of temperate Europe in the early Middle Ages (especially 1150-1300) and recently (especially since 1850). The period of distinctly colder climate which intervened (especially 1550-1700) is also clearly seen: it appears that the prevalence of cold months was specially marked in Britain and Russia, possibly associated with frequent cold airstreams from the north in the Norwegian Sea and over the Russian plain.

REFERENCES

- ¹ G. C. Simpson, "The distribution of terrestrial radiation", *Memoirs of the Royal Meteorological Society*, vol. iii, no. 23, 1928, pp. 53-78; and H. H. Lamb, "Fundamentals of Climate", Chapter II in *Descriptive Palaeoclimatology* (Interscience Publishers Ltd.), A. E. M. Nairn (ed.), New York, 1961.
- ² H. H. Lamb, "Differences in the meteorology of the northern and southern polar regions", *Meteorological Magazine*, vol. 87, Dec. 1958, pp. 364-79.
- ³ For a more detailed description see H. H. Lamb, "Representation of the general atmospheric circulation: an exhibit in the Royal Society Exhibition", *Meteorological Magazine*, vol. 89, Dec. 1960, pp. 319-30, especially Plate I, facing p. 320, "Schematic mean cross-section through the atmosphere and ocean from North Pole to South Pole in January near 30°W".
- ⁴ H. C. Willett and F. Sanders, *Descriptive Meteorology*, New York (Academic Press), 1959.
- ⁵ H. H. Lamb, "Fundamentals of Climate", *op. cit.*
- ⁶ C.-G. Rossby, "The scientific basis of modern meteorology", in U.S. Yearbook of Agriculture (*Weather and Man*), pp. 599-655, Washington, 1941.
- ⁷ H. H. Lamb, "Fundamentals of Climate", *op. cit.*, pp. 8-44.
- ⁸ H. H. Lamb, "Our changing climate, past and present", *Weather*, vol. 14, Oct. 1959, pp. 299-318; and H. H. Lamb and A. I. Johnson, "Climatic variation and observed changes in the general circulation", *Geografiska Annaler*, vol. 41, 1959, pp. 94-134.

International Tin Restriction and its Effects on the Malayan Tin Mining Industry

P. P. COURTENAY

ON 16TH NOVEMBER, 1949, the Singapore tin market was freed from the government control that had been imposed at the end of the war and the price of tin was able to find its own market level. Production in Malaya had rapidly increased each year since 1946 as rehabilitation of the industry went ahead after the Japanese occupation and in 1949 54,910 tons of tin were mined (see Fig. 1). However, the tin market had barely had time to accustom itself to the new free-trading conditions when the outbreak of the Korean War in 1950 provided dramatic evidence of that same inability of the industry to adjust output to meet world demand as had led to the three International Control Schemes of the 1930s.¹ The average price of tin, which had been M\$295 a picul* in 1949, rocketed to M\$367 in 1950 and M\$527 in 1951, whilst output barely altered—in 1951, in fact, it was 370 tons less than in the previous year (Fig. 1).²

To understand the reasons that lie behind this inelasticity of supply, it is necessary to examine briefly the nature of the Malayan tin mining industry whose annual production represents about one-third of the total world output. Tin ore, or cassiterite, is the oxide of tin and occurs sparsely in quartz veins traversing the margins of certain types of granite which always carry tourmaline and sometimes topaz. Suitable geological conditions occur in the granite zone of the main ranges of Malaya, which extend from Perlis to northern Johore (Fig. 2). With the principal exception of the lode mine at Sungei Lembing in east Pahang, however, Malayan tin is not mined from the veins but recovered as grains and pellets of ore from placer washings at the break of slope, where it has been concentrated by stream action from the primary lodes. Most of the developed tinfields are on the western side of the Malayan ranges, a distribution which probably reflects the historical and economic conditions which have favoured the west, rather than any physical differences between the two mountain flanks (Fig. 2). Of the various fields, those in the Kinta valley region of Perak are the most productive at the present time and to date have yielded very nearly half of Malaya's total recorded production.

► Mr. Courtenay, lecturer in geography at the Avenue Training College, Southampton, was head of the geography department at Sultan Abdul Hamid College, Alor Star, Malaya, from 1957 to 1960.

* The Malayan dollar is worth 2s. 4d. sterling. 1 picul = 133½ lb. avoirdupois.

Reduced to its essentials, the mining of alluvial tin involves the excavation of the ore-bearing sediments and the separation of the heavy cassiterite from the unwanted silt and gravel. This can be done in a variety of ways, including the "panning" of likely streams by individuals (*dulang* washing), but the most economic and widespread methods are dredging and gravel pumping.³ All dredges are owned and operated by European companies, and account for about 60 per cent of all the tin produced. A mining dredge consists of an excavator and a concentrating plant mounted on a floating barge in a pond or pool. It excavates along a face of earth, washes and screens the alluvial material to recover the ore, and rejects behind the dredge the waste material which gradually fills in the pool. The largest dredges have a monthly capacity of nearly 500,000 cubic yards and can work to depths of over 100 feet. The capital outlay to instal such a dredge and the associated tin-dressing sheds at present-day costs is in the region of £1 million.

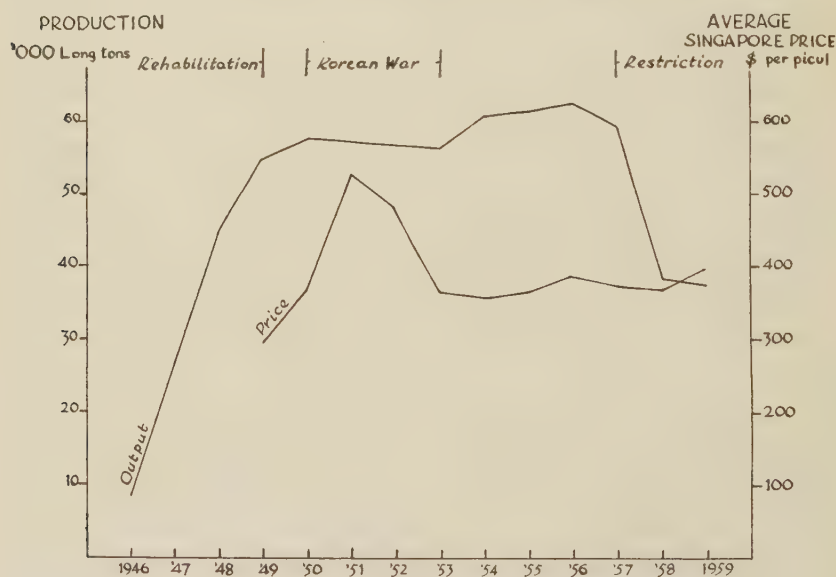


Fig. 1.—Malayan tin production and Singapore price, 1946–59.

The Chinese mining companies, whose financial resources, for various reasons, are more limited, employ the smaller-scale gravel pump method. To some extent this is complementary to dredging since it can operate in sites where complete recovery by the latter method is neither practicable nor economically justified. A pit is dug in the ore-bearing deposit, and a pump supplies water to monitors which excavate the face of the pit and carry the gravel to a sump. From the sump it is pumped to a series of long sluice boxes on a trestle with a gradient sufficient to ensure a controlled flow. The heavy cassiterite is caught behind baffles of various depths and later raked out. The

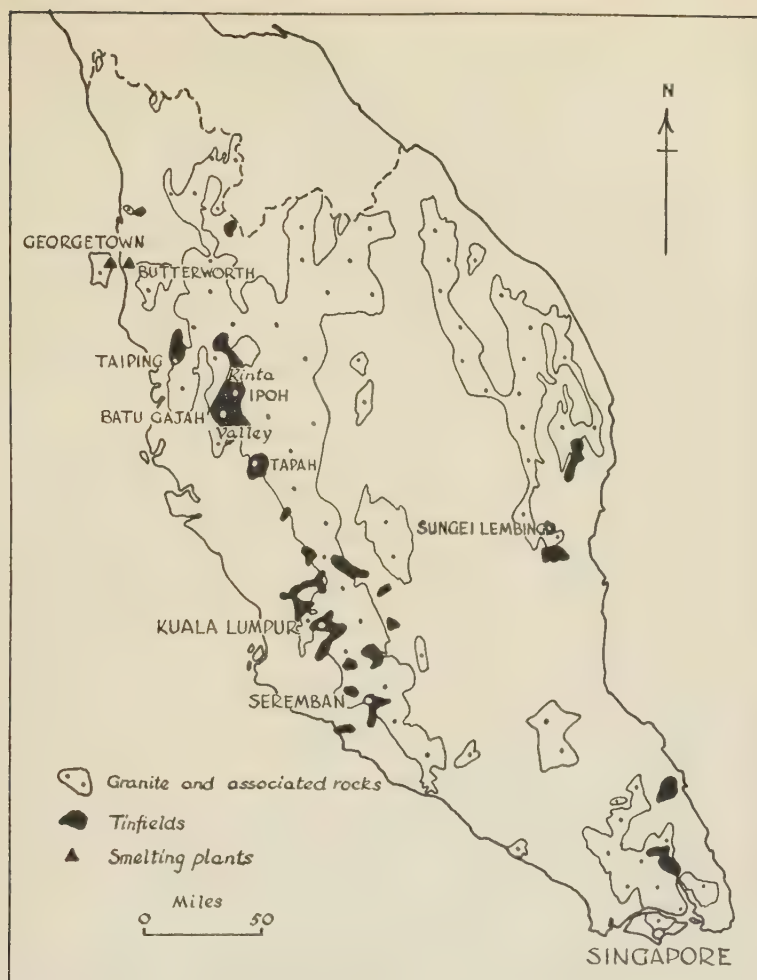


Fig. 2.—Distribution of developed tinfields in Malaya.

capital cost of installing such gravel pump equipment is between £10,000 and £15,000.⁴

The nature of both the principal mining methods makes it very difficult for either group of producers readily to vary output to meet short-term changes in the world demand for tin. If demand and prices fall, the small-scale Chinese producer, usually a sole proprietor or a partner, is not willing to sacrifice his livelihood by reducing output and so decrease his income even further; the heavily capitalized European company prefers to continue producing, in the hope that the price will improve, rather than face the rapid deterioration of idle equipment or the flooding of mines. Equally, in a period of high prices, increased output is difficult without further capitalization, the purchase and development of more mining land and the employment of more labour.

The high cost of installing new equipment and the problems involved in the alienation of further land for mining are likely to deter companies from expanding, since the price of tin may well have dropped again by the time the expansion has taken place. Since falls and rises in demand are not easily met by corresponding falls or rises in output through the normal price mechanism, price fluctuations are accelerated. When, as happened during the Korean War, demand increases suddenly and violently, price changes can be very great indeed. These changes have been further intensified since the war by United States stockpiling policy. During periods of international crisis the United States government increases its purchases for strategic purposes in excess of its immediate needs but, when international affairs improve, the abnormal purchases cease and the accumulated tin may even be released on to the commercial market.

Where the price mechanism has failed to regulate the output of tin to balance the demand, the governments concerned have taken action to protect the industry as a whole from the worst effects of the price fluctuations, and also to protect their own incomes, which are obtained partly from the export duty on tin and, in Malaya especially, from the high income tax on their profits paid by the mining companies. Pre-war restriction schemes, which worked only moderately well, were succeeded in 1953 by an agreement produced by the United Nations Tin Conference⁵ and later ratified by the majority of the world's tin producers and consumers.* In this agreement the inclusion of consumers improved it considerably in comparison with earlier schemes. It arranged for the restriction of output by producing countries on a system of quotas during a period of low prices, and a "buffer stock" to even out minor fluctuations. The manager of this buffer stock is required to sell tin, contributed by the producing countries, when the price on the London Metal Exchange rises as high as or higher than a stated ceiling price, and to buy tin, with funds contributed by the participating governments, when the price falls to or beneath a stated floor price. These prices are subject to revision from time to time as conditions change.

Market trends 1953-1960

The end of the Korean War in 1953, and the consequent slackening of demand, brought the price of tin back almost exactly to its 1950 level, though labour and other costs that had risen during the war remained high. During the second half of 1954 and throughout 1955, under the stimulus of continued accumulation in the United States stockpile and of a modest trade boom, production and prices slowly

* Principal non-members were U.S.A., Western Germany, Japan (consumers), and the U.S.S.R. and China (producers).

increased. This trend continued into 1956, but the gradually developing world trade recession of 1957 was keenly felt by the tin industry and prices declined rapidly after April. The lowest price for over three years was reached in November, and on 15th December the International Tin Restriction Scheme came into operation.

Table I

INTERNATIONAL TIN RESTRICTION: PERMISSIBLE EXPORTS FROM MALAYA^a

1st control period	(Jan.-Mar. 1958)	..	..	10,125 tons
2nd "	" (April-June 1958)	..	..	8,625 "
3rd "	" (July-Sept. 1958)	..	..	8,625 "
4th "	" (Oct.-Dec. 1958)	..	..	7,500 "
5th "	" (Jan.-Mar. 1959)	..	..	7,500 "
6th "	" (April-June 1959)	..	..	8,625 "
7th "	" (July-Sept. 1959)	..	..	9,757 "
8th "	" (Oct.-Dec. 1959)	..	..	11,838 "
9th "	" (Jan.-Mar. 1960)	..	..	13,590 "

Export quotas, which are fixed for three-month periods, were cut twice during 1958 (Table I) and prices gradually began to show an upward trend, with a marked jump in July when international tension increased in the Middle East after the Iraqi revolt and the landings in Lebanon and Jordan. During the summer of 1958, however, the activities of the Tin Council were offset by the rising volume of tin offered on west European markets by the U.S.S.R. and China, neither of which was a member of the agreement. By September, Russian sales had reached 18,000 tons, and had strained the tin agreement's stabilization system so much that it was on the point of collapse. The working of the agreement finally came to a halt later in the month owing to the exhaustion of the buffer stock funds. The London Metal Exchange halted all dealings and the price slumped to the lowest point reached during the year. It picked up again a little when the market re-opened following severe import restrictions imposed on Russian tin by the British and other European governments.

During 1959, the control scheme increased its grip on the situation and was helped by the general recovery of world industrial production. Prices rose and permissible exports were increased though, in view of the low quotas in the early part of the year, Malaya's output for 1959 was the lowest for twelve years. By January 1960 the situation was almost back to normal—quotas represented over 90 per cent of the pre-control quarterly average and there was even some doubt amongst miners whether the Malayan quota could be met. A government statement said that all mines that were operating between January 1953 and December 1957 would be allowed to resume operations in 1960, and that applications for new mines would be considered. Some mines hesitated to re-open, however, in view of the continuing uncertainty and also because of increased production costs caused by a tax on fuel oil that had been imposed at the end of 1959.

The geographical consequences of restriction

The introduction of tin restriction in December 1957 and the succeeding cuts in Malaya's export quotas had a number of geographical consequences, of which the closing down of a large number of mines and the dismissal of many thousands of workpeople were the most significant. Immediately before the period of restriction, there were 738 active tin-producing units in Malaya employing 36,585 people. Seventy-six of the units were dredges, 597 were gravel pumps, and the balance consisted of hydraulic workings, opencast and underground mines and a few unclassified workings. During 1958 most months saw mines of all types being closed and labour dismissed, so that by February 1959 only 386 units were operative (including 40 dredges and 303 gravel pumps) and employment in the industry had fallen to 21,519. This proved to be the worst month for the industry and corresponded with the announcement of the first increase in quotas (Table I). From March, mines slowly began to re-open and employment to increase so that, by the end of 1959, 483 units were working and the labour force numbered 23,778. Table II illustrates the number of tin-producing units of various types that were operating in each month from December 1957 to December 1959.⁷

The greatest number of closures in one month occurred in February 1958, following the initial restriction of output, and there was a further considerable drop in May when quotas were cut in the second control period. Of the two types of mine responsible for the bulk of the production, the gravel pumps closed most rapidly, there being 112 fewer in operation in February than in January 1958. The dredges ceased operations more gradually, the largest number to close in any one month was 9, these in May 1958. The very much smaller scale of operations of the gravel pumps made it possible for them to close, and also later to open, with less trouble and expense than the much larger dredges. Further, the difference in output caused by the closing or opening of one dredge (it being remembered that the 76 dredges working before restriction produced 60 per cent of Malaya's total annual output) is considerable, so that only a few need cease operating to cut production drastically. Equally, quotas must be raised to a considerable extent to permit many dredges to re-open.

Unfortunately there is no information available to show the distribution of the closed mines, but there is no doubt that the great majority were in the Kinta valley region of Perak and the Kuala Lumpur district of Selangor, in which two areas the bulk of Malaya's tin is produced. It is reasonable to assume that older, less economic mines, and those working lower-grade deposits would be the first to close, but no direct evidence is available. The hydraulic workings and the underground mines were the least affected by closures, probably in view of their very minor contribution to total output.

Table II
NUMBER OF ACTIVE TIN PRODUCING UNITS

<i>Month</i>	<i>Dredge</i>	<i>Gravel Pump</i>	<i>Hydraulic</i>	<i>Open Cast</i>	<i>Under- ground</i>	<i>Other</i>	<i>Total</i>
Dec. 1957	76	597	10	4	25	26	738
Jan. 1958	76	573	11	4	24	28	716
Feb.	71	462	7	4	22	25	591
March	69	459	7	4	23	26	588
April	63	430	10	3	23	28	557
May	54	335	11	2	22	23	447
June	46	349	8	2	22	22	449
July	47	360	8	2	22	26	465
Aug.	41	327	5	1	21	27	422
Sept.	40	321	5	2	21	23	412
Oct.	41	323	8	2	22	26	422
Nov.	41	305	9	1	20	24	400
Dec.	34	333	9	1	19	21	417
Jan. 1959	41	314	7	2	17	23	404
Feb.	40	303	6	2	15	20	386
March	34	331	6	1	17	19	408
April	40	332	9	1	19	19	420
May	40	330	7	2	18	15	412
June	39	323	9	2	20	15	408
July	40	342	8	1	19	19	429
Aug.	38	339	8	1	15	19	420
Sept.	35	356	7	1	17	17	433
Oct.	42	368	8	1	17	19	455
Nov.	47	374	7	1	16	18	463
Dec.	45	392	9	0	20	17	483

The amount of unemployment that resulted from the restriction of tin production was considerable. At one time over 15,000 workpeople had been dismissed from the mines alone, but unemployment was not limited to this figure. Dismissals became necessary from foundries and other businesses depending directly on the tin-mining industry. Staff were later put off by other small business houses and retail shops, and many—working, as is typical of so many small-scale Chinese concerns, on the narrowest of profit margins—were forced to close down as money became scarcer in the tin areas. Much of the unemployed labour, with typical Chinese resilience and initiative, turned to alternative money-making ventures. Some began raising pigs, poultry and vegetables, others went to work on rubber estates or began to plant padi or tobacco, while yet others obtained work as loggers or hawkers, selling anything that would find a buyer. Some mining companies, instead of retrenching labour, provided plots of mining land for their workpeople to raise vegetables. One company in Perak allocated 59 acres, from which produce was soon being marketed, whilst another company in the same state allocated 250 acres that were soon under vegetables, sweet potatoes, tapioca and fruit trees.⁸ Despite these palliatives, however, considerable hardship was felt by many in a country which has a labour surplus at the best of times and where no universal schemes of assistance for the unemployed exist.

The tin-smelting industry also clearly felt the effects of limited output. One-third of the world's output of tin is smelted in Malaya, largely at two plants—the Eastern Smelting Co. Ltd. at Georgetown,

Penang, and the Straits Trading Co. Ltd. at Butterworth, Province Wellesley. As a result of restriction the latter company ceased to operate its Singapore plant, which had been, in any case, of very minor importance since the war, and concentrated its activities at its very modern Butterworth smelter, though this was not working anywhere near capacity. During 1959, the Eastern Smelting Co.'s plant at Georgetown was using only one-quarter of its available furnaces and had dismissed about one-third of its daily paid labour force. An interesting minor result of the restriction of output from the principal suppliers of tin ore to the smelters—Malaya and Thailand—was a relative increase in the importance of small-scale suppliers, especially Burma, Laos, Australia and East Africa whose exports, because small, were not limited.

The concentration of all smelting in northwest Malaya almost entirely eliminated Singapore as a tin-exporting port. In 1959 only 1 per cent of the tin ore produced in Malaya moved through Singapore, and this was probably only transshipment from south Malaya to Penang. The remaining 99 per cent of Malaya's production was exported direct through Penang. As a result of the change in the pattern of smelting since the war, Singapore had already greatly declined as a tin exporter before restriction, and it now seems unlikely that it will ever be of significance again as a tin-smelting or exporting centre.

The future of the Malayan tin industry

The present International Tin Agreement expires on 30th June 1961, and during May 1960 a conference was held in New York to draft a new agreement. In order to improve upon the former agreement governments which did not participate in it, especially the U.S.S.R., were invited to join.⁹ It is, of course, impossible to forecast the future demand for tin and the effects that this will have on prices, but it seems less likely now than it did a few years ago that world demand may fall. Following economies and technological improvements, such as electrolytic tinning, developed by the main consuming industries during and after the Second World War, it did at one time seem probable that the world consumption of tin would gradually decline. However, even though the tinplate industry is using far less tin per ton of finished plate than it did before the war,¹⁰ the total demand for the product at present is far greater than it was in pre-war days. Rising living standards lead to an increase in the consumption of canned goods in western nations, and even in countries like Malaya itself, whilst the popularity of canned beer and soft drinks is growing.

A greater danger to Malaya than falling demand is the possibility of a declining supply as the country's richest mining land is worked out. Malaya's all-time record production was in 1940 when 80,561 tons were mined, a total that has never been approached since; the post-war record year (1956) produced only 62,226 tons. If bigger dredges have

to be employed to re-work old mines or to develop very low-grade deposits a rise in prices is inevitable. This will almost certainly increase the research into substitute alloys already actively pursued in America,¹¹ and may stimulate production further in basically higher cost areas like Bolivia. According to a recent estimate,¹² Malaya's tin reserves will last only another 25 to 30 years at the pre-restriction rate of exploitation, though this period could be considerably prolonged by the discovery of new tin fields in the undeveloped east coast states. Whether it is to be due to falling demand or increasing costs, it seems extremely likely that the tin industry's contribution to the Malayan economy is destined to decline. Originally responsible for the early opening up of the peninsula in the second half of the nineteenth century, it has been pushed into second place in importance by rubber in the first half of the twentieth. The probable further decline in tin's significance emphasizes the need for Malaya to diversify its economy by increasing its range of agricultural products and secondary industries, as it matures from being a primary producer to becoming a more balanced economic unit.

REFERENCES

- ¹ See A. W. King, "Changes in the tin mining industry of Malaya", *Geography*, vol. xxv, 1940, pp. 130-4.
- ² All 1949-54 figures as quoted in *The Economic Development of Malaya*, International Bank for Reconstruction and Development, Govt. Printer, Singapore, Sept. 1955, p. 245. Output figures 1955-9 as published in *Straits Times* "Market Review" of 29th January 1960. Average prices 1955-9 as published in *Straits Times* of 2nd January 1960.
- ³ It is impossible to generalize about the comparative production costs of the two main methods in view of the very variable nature of the deposits even within very small areas, though figures mentioned in the International Bank's Report on *The Economic Development of Malaya* (p. 249) suggest that the operating costs of dredges are slightly lower per picul of tin ore produced than are those of gravel pumps.
- ⁴ *The Economic Development of Malaya*, *op. cit.*, pp. 247-8.
- ⁵ The objectives of the International Tin Agreement are as follows:
 - (a) to prevent or alleviate widespread unemployment or underemployment and other serious difficulties which are likely to result from maladjustments between the supply of and demand for tin;
 - (b) to prevent excessive fluctuations in the price of tin and to achieve a reasonable degree of stability of price on a basis which will secure long-term equilibrium between supply and demand;
 - (c) to ensure adequate supplies of tin at reasonable prices at all times; and
 - (d) to provide a framework for the consideration and development of measures to promote the progressively more economic production of tin while protecting tin deposits from unnecessary waste or premature abandonment.
 United Nations Tin Conference, *International Tin Agreement* 1953, Govt. Printer, Kuala Lumpur, 1958, Article I, p. 1.
- ⁶ Figures as published in the *Straits Times* of 2nd January 1960.
- ⁷ Figures supplied by the Department of Mines, Federation of Malaya, Kuala Lumpur.
- ⁸ *Report of the Department of Labour and Industrial Relations*, Kuala Lumpur, March 1959, p. 14.
- ⁹ The principal change resulting from the May 1960 meeting of the International Tin Council was that when the new scheme comes into operation in 1961 it will include a number of new consuming nations. West Germany and Japan are the most important of these, but Belgium, Guinea, Korea, Mexico, Spain, Turkey and the U.A.R. are also new members. Neither the U.S.A. nor the U.S.S.R. has changed its mind and joined, so their absence is likely to remain the scheme's main weakness.
- ¹⁰ *The Economic Development of Malaya*, *op. cit.*, p. 251.
- ¹¹ See comments by Sir Douglas Waring (one-time adviser on tin to the Malayan Government) reported in the *Straits Times*, 15th October 1959.
- ¹² Siew Nim Chee, "The Tin Mining Industry in Malaya", Chapter 5 in *Problems of the Malayan Economy*, ed. Lim Tay Boh, Donald Moore, Singapore, 1957, p. 36.

Blackboard and Camera

Some Combined Uses in the Teaching of Geography

P. J. M. BAILEY

THE PREPARATION OF MAPS, DIAGRAMS AND SKETCHES suitable for classroom use is a perennial problem for teachers of geography. It is generally agreed that, ideally, most visual aids to oral exposition should be built up by the teacher during the lesson, probably on the blackboard, the main exception being, of course, materials which are projected. Only thus may the mutual relevance of oral and visual teaching be assured, the pupils' own contributions fully incorporated into all aspects of the work, and the teacher freed from the temptation, if not the necessity, of planning lessons to fit the aids available, instead of vice versa.

In practice, however, the constant pressure of work to be covered within a limited allocation of timetable space renders the really thorough working-up of visual materials, on the blackboard or by other means, something of a luxury, to be indulged in only for a limited number of topics. For the remainder, time allows only a basic minimum of blackboard and other display work to be attempted. It is under these conditions, by no means confined to the G.C.E. classes of grammar schools, that the combined use of blackboard and 35 mm. camera has been developed. The technique opens up a whole field of possibilities for the rapid production by the teacher of visual materials which are thoroughly relevant to his own individual needs, aesthetically pleasing, permanent in form, and no more expensive than aids prepared in any other way, or purchased from commercial sources, once the initial outlay for a camera has been met.

In connection with this last point, certain Local Education Authorities and some large schools already possess 35 mm. cameras, which they make available to departments and individual teachers for approved uses. It is much to be hoped that this provision will be more widely extended in the future.

Technique

It is possible, and indeed a simple matter, to photograph blackboard drawings on colour film of the "reversal" type. The resulting transparencies can then be mounted between glass, and become to all intents and purposes permanent. They may then be projected either in total darkness, or on a daylight projection screen.

➤ Mr. Bailey is head of the geography department at St. Peter's College, Saltley, Birmingham.

Drawings may be made more quickly and easily on a blackboard than on paper, since mistakes merely have to be rubbed off and replaced, and over-elaboration is far less a temptation using chalks than pen-and-ink. To obtain pleasing results photographically, the blackboard must be in good condition, and is best washed before use. The question of a suitable size for drawings sometimes poses a problem for the beginner in photography; the writer uses a portable board 4 feet by 3 feet, which fills the view-finder of a normal 35 mm. camera at a range between 5 and 6 feet. This may prove rather small for drawings that need a considerable amount of writing or printing to be added. Pencil lines may be ruled on the board as an aid to writing, or used as guide-lines for drawing, and will not appear on the finished transparency provided they are kept really thin. A broad margin should be left around drawings to allow for the fact that mounting frames are always a little smaller than film-size.

All chalk-work should be bold, clear and as simple as possible. It is a good idea to plan out a standard table of colours and symbols in advance, so that as many drawings as possible may be made visually comparable. Thus, on maps, block-diagrams and sketches the writer always uses greens and browns for relief features and for agricultural information, blue for water, green for ice, orange for railways, red for details of settlement, mining and industry, white for titles, most lettering and statements of direction and scale, and yellow for all items requiring emphasis, whatever their category. Purple never shows up well, and is best omitted. On geological drawings all the colours are used over again, with standardized representations for major rock-types and certain mineral deposits. A third table of colours is used for climatological and meteorological drawings; and so on.

Certain useful effects can be obtained by a judicious use of colours. Brown shading appears closer to the eye than either the plain blackboard surface or blue lines; and detail in orange or red appears to stand up from any background colour, producing an almost three-dimensional effect when projected.

Photography is best carried out in bright sunlight, which gives results far superior to any obtainable in artificial lighting; hence the value of a portable blackboard. The camera should be mounted on a tripod, and the fastest exposure given commensurate with an aperture of about $f.4$, which is close to the optimum optical performance of standard lenses. The correct exposure is determined most accurately by means of a photo-electric light-meter, which should be held about three inches from the brightest part of the drawing. If a slight under-exposure then be given, the surface of the board will be rendered completely black, and minor marks and irregularities concealed. The exposure may also be calculated rather more approximately from the chart enclosed in every carton of colour film.

Close-range photography presents certain parallax difficulties unless the camera being used has its range- and view-finders automatically coupled and corrected. These difficulties have to be overcome initially by making a series of trial exposures at carefully measured distances from the board, so that the precise fields of view of lens and view-finder may be determined, and the necessary corrections noted. During the trials, and indeed at all times, particular care should be taken to place the camera lens opposite the central point of the blackboard, and to avoid tilting either board or camera. Black-and-white film may be used for the trials, and need only be developed. With regard to view-finders, the bright-line variety is most convenient for close-range work, especially if the photographer wears glasses.

Two final technical points are worth mentioning: first, if the blackboard base is placed at 45° to the sun's rays, board-shine will be eliminated, and the photographer will not be able to cast his own shadow, or that of his equipment, on to the blackboard, a mischance that happens all too easily. Second, photography in the late afternoon or evening is to be avoided, as the reddish light of the sun will alter the chalk colours and render white, yellow and orange nearly indistinguishable.

Applications

Possible applications of the blackboard and camera technique are many and varied; the suggestions made here are based upon ideas so far worked out by the writer, and are not meant to be exhaustive.

First and foremost, the technique lends itself to the building up of sequences of drawings. The lesson to be illustrated is first broken down into its major teaching stages, and a basic map or diagram drawn on the blackboard and photographed. Details appropriate to each teaching stage are then added to this drawing, each set of additions being photographed. The final result is a series of transparencies recording in permanent form the blackboard work which would be done during the lesson were unlimited time to be available.

In the classroom, the transparencies are shown as the lesson proceeds, preferably on a daylight projection screen so that the pupils may make notes. In many cases they will be alternated with other slides, where possible the teacher's own or cut from commercial filmstrips. The blackboard itself now becomes a species of rough notebook complementary to the projected sequence of drawings, where additional material, such as more up-to-date statistical information and the results of class discussion, is entered. Following a period of practical work, the sequence will be repeated quickly to consolidate the points taught, and then kept for later use as a revision summary.

An actual example will serve to explain the method further. It was used recently in a junior secondary school mapwork lesson, the aims of which were to show how the scale of a map determines the amount of

detail which can be shown, and the degree to which such detail has to be conventionalized, and to draw attention to the limitations of small-scale maps as sources of geographical information.

A basic drawing was prepared showing, as from an aeroplane, a four-square-mile section of the East Anglian countryside, using only the information given on the British Isles map in a Russian school atlas. This drawing showed a completely flat landscape without drainage, crossed and indeed largely filled by a straightened and enormously wide railway, about as wide, to scale, as the black line on the map. There was no other detail. Next, the one-in-a-million map in a British atlas was examined, and all detail shown within the chosen area added to the first drawing. Care was taken not to include anything by way of interpretation, but to represent the landscape strictly as it was shown by the map. Thus, towns and villages were shown by purely conventional circles; no churches appeared on the map, and so the common method of drawing a church tower and a cluster of houses to represent a village was not used. The railway was duly reduced in width. The process was repeated for the Ordnance Survey quarter-inch, one-inch and 1 : 25,000 maps, each drawing being photographed in turn. The sequence ended with a sketch showing a small part of the countryside as it might actually appear from the air. In the lesson this served to introduce a class discussion on the nature of maps in general, the limitations of various scales, including very large scales, and the need for conventional signs.

In the field of physical geography, where sequential diagrams have long been used in books and papers, the blackboard and camera technique has proved itself well adapted both to illustrate the overall development of landscape and to explain detail. To give an example of the former: a useful sequence of drawings may be prepared to show the stages by which a landscape of rounded hills and water-cut valleys might be glaciated and then re-exposed to the normal cycle of erosion, each drawing being derived from the one preceding by suitable erasures and additions. Significant detail from each stage may usefully be picked out by arrows, ready to be illustrated during the lesson by colour transparencies, filmstrip frames or the map representation of actual examples, or linked with pupils' own observations made in the field. Sequences on similar lines may be worked out to illustrate the retreat phases of an ice-sheet, the effects of sea-level changes on a landscape, the development of drainage patterns and of karst topography; further possibilities will clearly suggest themselves. The value of working local features into the drawings wherever possible hardly needs emphasis.

Two or three sequential drawings may often be used to explain the development of specific physical features, but in many instances these are simple enough to be put directly on the blackboard as the lesson

proceeds. Photographed sequences are, however, always useful for revision purposes. The writer has found useful sequences explaining the formation of rias, river terraces, and the glacial lake-stadial moraine-gorge combination commonly found in the northern dales. Sequences of the "strip-cartoon" type have occasionally been used in junior schools, for example one suggesting some possible effects of the ice-caps' melting at the present day.

Finally on the physiographic side of the subject, the writer has made constant use of drawings which merely pick out and label the features shown in a colour transparency or filmstrip frame. It is a fact still not widely enough recognized that a person's understanding of a photograph depends very much upon his background experience. Thus, when the photograph of a physical feature, such as a river terrace or moraine, is projected, pupils tend to find its interpretation more difficult than the teacher anticipates. This is particularly the case where he himself is the photographer: automatically he visualizes the three-dimensional reality of his subject, its scale and its setting in the landscape, while they see only a flat picture with much of the setting excluded. A plain line-drawing outlining the feature, indicating its size and the distance away of a number of points, and showing how it fits into the landscape as a whole will invariably bring out the teaching points in the photograph far more efficiently than a verbal exposition alone.

On the human and economic side, applications of the blackboard and camera technique are at least as numerous as on the physical. The writer has found it particularly useful when dealing with the development of towns. It is all too usual for school geography lessons to treat towns merely as places where certain industries are carried on, whereas their great interest for geographers, professional and pupil alike, lies in tracing their growth and changing functions historically, and relating both to site factors and changing geographical situations.

A sequence of blackboard drawings can help greatly in presenting the geography of a town developmentally in this way. The writer begins with a bold, simple sketch-map, partly pictorial, of the town site, and adds significant detail for a succession of historical periods, finally building up a sketch-map of the modern town. A set of colour transparencies and one or two air photographs are assembled for concurrent use in the classroom; these illustrate the present-day appearance of features shown on the drawings. A recently completed sequence on Norwich developed as follows: (1) the physical site, with indications of the original vegetation cover; (2) details of pre-Roman and Roman settlement and communications; (3) the founding of Conesford and Coslany, Saxon fishing hamlets beside the Wensum, with their common market-place at Tomland; (4) the addition of Danish settlements; (5) the first Norman additions—castle, a new market-place, cathedral-priory, early churches; and so on through the centuries to modern

Norwich with its spreading suburbs. A similar sequence has been worked out for Birmingham; comparison of the two sequences helps to explain why the towns are today so very different in functions and appearance.

Other possible uses for sequential drawings on the human and economic side include the building up of composite landscape sketches, in which the more important elements in the landscape of a selected geographical region are combined step-by-step to produce a visual regional summary; the representation of such projects as the St. Lawrence Seaway and Snowy Mountains schemes; explanations of the location of certain industries and of industrial organization and techniques. Single drawings are also useful: these most frequently take the form of labelled analyses of detail shown on a slide, or drawings to which a set of slides are to be related, such as a sketched panorama of a town, showing its functional zones.

Enough has been said to show that the combined use of blackboard and camera holds out a number of possibilities for teachers of geography. No reference has been made to its applications to other subjects in the curriculum, and it is hoped that this paper may stimulate further experiment transcending formal subject boundaries.

This Changing World

THE 1961 CENSUS OF ENGLAND AND WALES

As at midnight on 23rd April, 1961, the sixteenth census of population of England and Wales was taken. For the first time the census results will be tabulated by I.B.M. electronic computer which will give the results much more quickly and should permit much more rapid publication of data than in earlier censuses. The 1961 census is also of unusual interest in that for the first time it is making use of a 10 per cent sample enumeration to answer many of the questions, with consequent savings of time and cost. This follows the success of the 1 per cent sample used in the 1951 census which led to speedy and accurate provisional results. Moreover the Registrar General has agreed, for a small fee, to prepare tabulations for area units smaller than those used in the published volumes. It may therefore be of interest to geographers to know of the data which have been collected, the changes in these compared with previous censuses and something of the use which can be made of tabulations for small areas.

The questions to be asked in the census were set out in Statutory Instrument 1960, No. 1062 and these may be briefly summarized as follows:

I. On all returns (to be made by the head of every household) a variety of questions relating to both demographic and housing conditions were asked.

(a) *Demographic*—all persons in residence and their relationship to the head of the household; sex, age and marital status; usual place of residence, birthplace (by country) and nationality.

(b) *Housing*—number of rooms, whether the building purely residential or with two or more dwellings; availability of amenities such as water, w.c., bath, cooking facilities and sink; a new question on types of tenure (owner-occupied, rented etc.).

II. On special forms delivered to 10 per cent of households the questions included those listed above under I, plus the following:

(a) *Employment* (of persons aged 15 or over) by occupation, industry and workplace; whether in full-time or part-time employment.

(b) *Education*—the age at which full-time education ceased, together with a new question on qualifications held in science or technology.

(c) *Migration*—this is a new question asking for the usual address on 23rd April, 1960, and, if this is the same as on census night 1961, the length of residence at that address. This gives, for the first time in Britain, direct information on trends in migration.

The questions asked therefore were much as in 1951 except for those on tenure of property, scientific qualifications and migration. In certain cases, however, there has been a loss in the detail required: birthplace is now stated in terms of country of birth only, a question of little value in assessing long-term population mobility within England and Wales, whereas hitherto the *county* of birth had been given.

To the geographer in particular, the areal units for which these data are processed and published are of fundamental importance. Here the problems have always been two-fold: first, the variation in units of enumeration from census to census and second, the size of the unit of tabulation. The main units for which data will be tabulated and published in the 1961 census are the

administrative county and the large towns (including county and municipal boroughs), though totals of population will be enumerated by township and urban ward as well as for the larger administrative areas. Thus there is continuity with the practice since 1911, although, of course, there will have been numerous boundary changes since 1951.

The second problem, that of the adequacy of the size of the unit of tabulation, presents greater difficulty. It is commonly agreed that for many purposes, notably for studies in social geography, the county and county boroughs are of use only in general studies and that even the ward and township are too large for many purposes. (See E. Jones, *A Social Geography of Belfast*, London, 1960, and "Sociological aspects of population mapping", *Geography*, vol. xlvii, 1961, pp. 9-17.) In this matter, indeed, the history of the census of England and Wales is in many respects one of diminishing returns. Nevertheless, following the example of the United States Bureau of the Census, new avenues were opened up in the 1951 census by the Registrar General making available data for small areas (known as Census Tracts) in the city of Oxford. These were units of some 3000 people made up of combinations of Enumeration Districts and designed to give units as socially homogeneous as possible.

Similar information is to be made available for Oxford from the 1961 census and a number of Universities elsewhere have asked for detailed tabulations. The Registrar General offered to supply for small areas a similar range of information to that available in the general tabulations, provided that these requests were made before general tabulation was commenced. This is to be extracted from the I.B.M. magnetic tape in the course of tabulation and will be made available on punch cards as soon as the results for the area in question have been processed. Thus considerable detail will be speedily available for small areas at an estimated cost of 30 shillings per unit. To show the potential value of this material reference may be made to plans for obtaining such information about Merseyside. Here, in consultation with local authorities, the University has taken the lead in asking for information for the 2000 or so Enumeration Districts within the Merseyside conurbation as defined in the 1951 census plus some fringe areas of rapid development (e.g. Maghull, Kirkby, Hale and Halewood).

The Enumeration District offers certain advantages over the census tract in that the material is available for small, flexible units of 1-2000 population which can be combined for detailed analysis in ways which would not be possible from the published returns. For example, ward boundaries in Merseyside have changed since 1951 but by combining E.D.'s it will be possible to compare with the 1951 areas. It will also be possible to reconstruct the "zones and sectors" used in the 1951 tabulations for the Merseyside conurbation which are not unfortunately to be repeated in 1961. For each E.D. the Registrar General has been asked to supply (a) the data collected in the full census and outlined under I (above) and (b) the following tabulations derived from the 10 per cent sample data (outlined under II above): *total of population* contained in the sample—since this may be small and the sampling error large, E.D.'s may have to be combined for analysis of 10 per cent sample data in certain cases; *changes of residence* either within the previous year or, if not within the fifteen years previously, since birth; age of termination of *education* in age-groups of each sex (up to 16 years, 16 to 19, 20 and

over); *employment* by broad occupational groups, and totals of occupied and unemployed; *socio-economic groups* of male persons (professional, employers and managers, skilled labour, non-manual, semi-skilled, rest); *place of work* (if in a different administrative area); *families per household*.

Without attempting to deal exhaustively with the practical value of such data it will be enough to point out that the City of Liverpool expects to use them as a necessary population base for the study of health and welfare needs, to assist in the investigation of housing standards and needs, to shed light on the structure of population in clearance and re-housing areas and, finally, to define catchment areas for such services as education and recreational facilities.

Within the University of Liverpool a number of departments are interested in the material: Economics in aspects of shopping areas; Geography in population structure and mobility (including the journey to work); Social Science and Civic design in social structure and characteristics, especially of the central districts, the local authority housing estates and areas of re-development.

The availability for the first time of such detailed information lends special interest to the 1961 Census of Population and augurs well for the future of social and demographic statistics in this country. Geographers should be aware of the possibilities that this opens up, not only in the fields of social and economic geography but also for local studies which can be of the greatest value both in research and in the school syllabus.

University of Liverpool

R. LAWTON

LE REMEMBREMENT RURAL EN FRANCE—A CASE STUDY FROM LORRAINE

A recent article in "This Changing World", described the distribution of remembrement operations in France (A. R. M. Baker, "Remembrement rural en France", *Geography*, vol. xlvi, 1961, pp. 60-2). A case study of these changes illustrates the impact of remembrement on a specific rural community, that of Vezelise, a commune of some 1200 inhabitants situated 25 miles south of Nancy, in Lorraine. The lands of this commune, formerly dominated by viticulture, were highly parcelled but by 1960 remembrement operations had been completed. By a comparison of the Ancien Cadastre of 1811 and the Cadastre Actuel of 1960, together with the Etat de Section documents relating to the two dates, the extent and nature of remembrement, both spontaneous and, more recently, official may be indicated precisely.

In 1811 the commune was subdivided into *sections* corresponding with the variations in quality of the land in relation to agriculture. Prior to remembrement, the individual land holders customarily held parcels of land dispersed throughout the sections of the commune. At the time of the Ancien Cadastre there were some 2643 such parcels in the commune. The nature of land holding and the high degree of parcelling are shown in Fig. 1, a detailed enlargement of Section B of the commune.

The detailed pattern of the 304 field strips indicates the degree to which subdivision of land had proceeded and the paucity of the roads for access to the individual strips. Plotted on the map are the strips belonging to three individual land holders as recorded in the Etat de Section for 1811. The

dispersion of the strips within the section is apparent, and to this must be added the fact that their remaining strips were dispersed throughout the

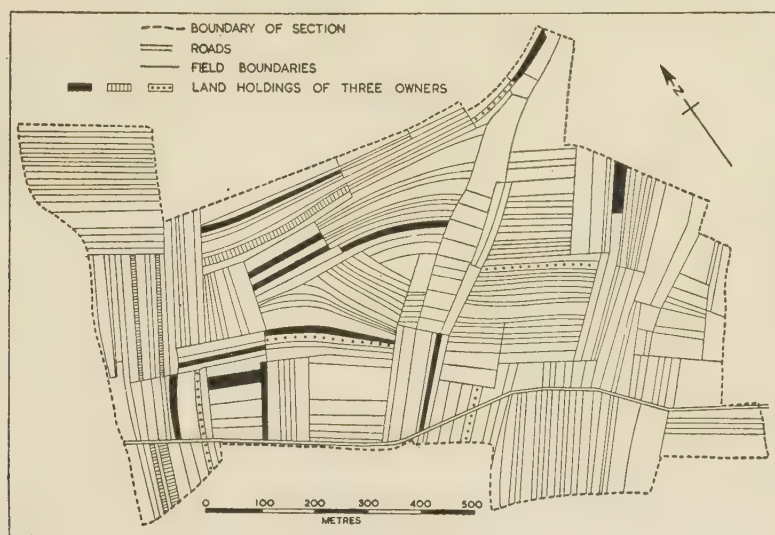


Fig. 1.—Vezelise—field boundaries in Section B in 1811.

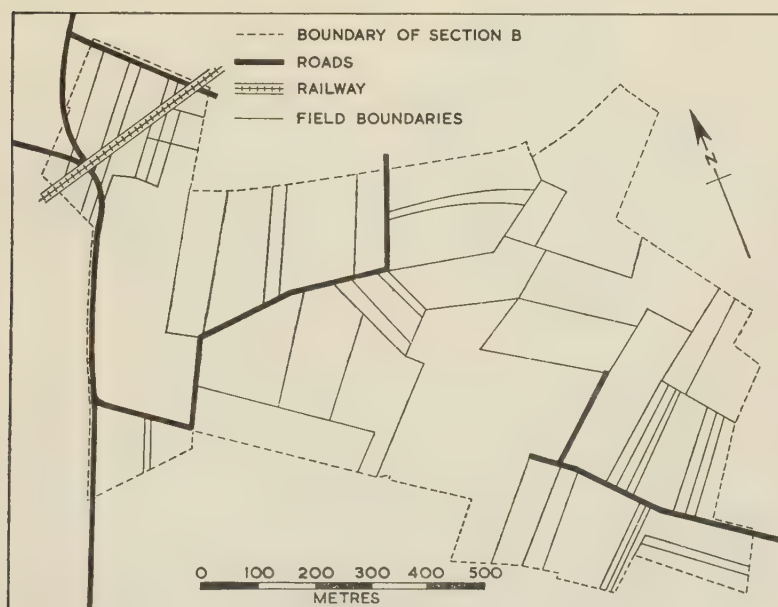


Fig. 2.—Vezelise—post-remembrement field boundaries in Section B in 1960.

other sections of the commune. The limitations on efficiency imposed by such a system of land tenure and the advantages to be gained from redistribution and consolidation of strips need little emphasis. The extent to which this process had been achieved in Vezelise by 1960 is illustrated in

Fig. 2 with reference to the same section B. The 304 strips of land shown in the Ancien Cadastre of 1811 had by 1960 been consolidated into 62 fields. This process has been achieved to some extent by *remembrement spontané*, the purchase of adjacent strips of land by individual land holders on their own initiative, but more particularly by official remembrement since 1941. The remembrement process was completed in Vezelise by 1960, by which date the number of fields in the whole commune had been reduced from 2643 (1811) to 358.

The impact of this remembrement on the rural economy has been profound. The larger field size, together with the improvement in access roads, has resulted in a considerable increase in mechanization. Secondly, the increase in field size, coupled with the enclosure by fences, has facilitated an increase in the significance of livestock and the importance of an integrated animal and arable system of farming. In terms of the agricultural labour force, remembrement, and the concomitant increase in efficiency and reduction of per acre labour input, has effected an overall reduction in labour demands and at the same time has strengthened the economic base of the commune. As the proportion of the total labour force employed in agriculture has declined in recent years in Vezelise, so the proportion employed in rural industries, particularly in brewing and dairy processing, has increased substantially. In Vezelise, therefore, unlike many other communes in Lorraine, rural depopulation has not been associated with remembrement.

University of Leeds

I. B. THOMPSON

DEVELOPMENTS IN THE LORRAINE IRON AND STEEL INDUSTRY

Trends in the Lorraine iron and steel industry were analysed in a paper in *Geography*, vol. xliii, July 1958. Further developments of geographical interest are taking place, notably in fuel supply and steel technology. The increasingly important role within Lorraine of the Moselle iron and steel district is also of significance.

Fuel supply

The trend towards increasing dependence on nearer sources of coke and coking coal, made possible by new coking techniques, was analysed in the earlier paper for the period 1952-7. The trend has since continued and Fig. 1 illustrates the extent of the change from 1952 to 1960. Coking plants located in Lorraine and the Saar supplied more than half the coke receipts of the Lorraine iron and steel industry for the first time in 1960, more precisely 50.3 per cent compared with 42.8 per cent in 1957 and 32.1 per cent in 1952. The Lorraine steelworks' own coke ovens drew 54.4 per cent of their coking coal from the Lorraine and Saar mines in 1960 compared with 51.3 per cent in 1957 and 37.9 per cent in 1952. In absolute terms the expansion of fuel supplies from nearer sources has continued steadily. When the advance of iron and steel output has slackened, fuel supplies from more distant sources have fallen. The iron and steel companies have recently reached agreements with the French and Saar colliery corporations to assure their future fuel supplies from the nearer sources. Meanwhile Ruhr

fuel has become available under easier conditions: earlier cuts in international railway freight rates enforced by the European Coal and Steel Community (ECSC) were followed in 1960 by two major cuts, made

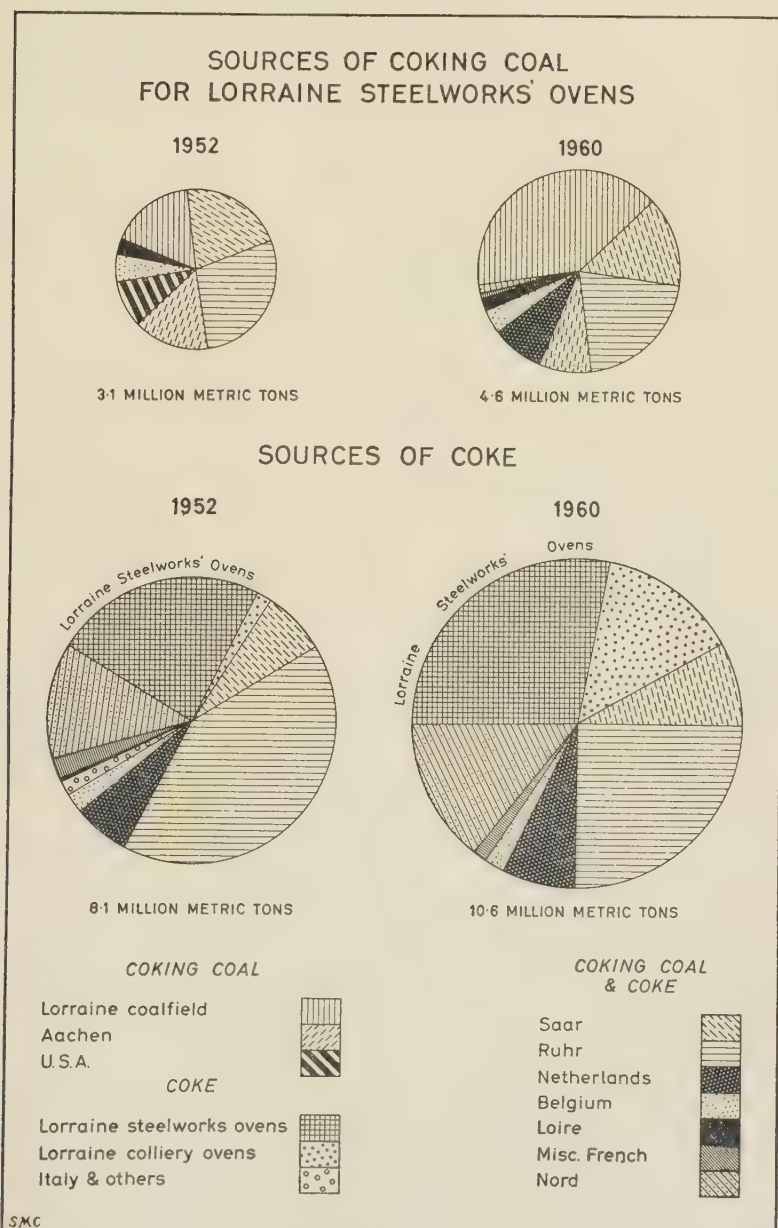


Fig. 1.—Sources of fuel for the Lorraine iron and steel industry, 1952 and 1960. Based on statistics of coke and coking coal receipts supplied by the Bureau de Documentation Minière (BDM) except that figures for coke supplies from Lorraine steelworks' ovens are of output (over 60 mm, adjusted figures) taken from BDM: *Statistiques mensuels*.

independently by the Germans, affecting deliveries from the Ruhr to Lorraine. The rail freight charge on a ton of coke from Gelsenkirchen (Ruhr) to Homécourt (Lorraine) was 25 per cent less in November 1960 than in February 1953. It is also of interest that the Ruhr colliery properties bought by a French steel consortium in 1954 supplied more than half the Ruhr fuel sent to Lorraine in 1957. The increasing use of sintered iron ore is also easing fuel costs by reducing coke requirements per ton of pig iron; these are expected to fall by 100 kg. per metric ton of iron, in France as a whole, by 1965 to 850 kg. per ton.

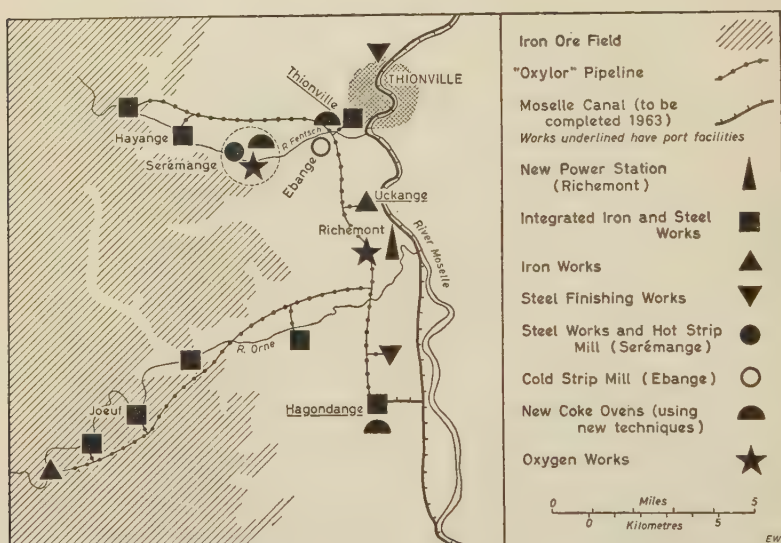


Fig. 2.—The Moselle district.

Steel technology

The bulk of Lorraine's steel output has long been produced by the basic Bessemer process, a fuel-less technique, able to use pig iron made from highly phosphoric ore but to take little scrap. Bessemer steels have had the disadvantage that they are suitable in quality for only a restricted range of products. The Lorraine industry has adopted with alacrity the new technique of using an oxygen-enriched blast in the Bessemer convertor, so obtaining a steel as good as that from the open-hearth furnace for making sheet and tinplate. By November 1960 three large oxygen factories serving the steel industry had been installed in Lorraine with a combined capacity of 900 tons per day. A more revolutionary process, now to be installed at one works, demands the use of pure oxygen injected into a rotating convertor through a manoeuvrable lance. This is the Kaldo process evolved in Sweden giving steel of extremely high quality, very low in phosphorus, sulphur and nitrogen.

Role of the Moselle District

The Moselle District, embracing the valley of the Moselle between Metz and Thionville with the tributary Orne and Fentsch valleys (Fig. 2), is the most important of Lorraine's three iron and steel districts and produced

63.4 per cent of the region's steel output in 1958. This was a modest advance on its earlier share, following the location at Serémange and Ebange of the new continuous strip mills (the "Sollac"—Société Lorraine de Laminage Continu—works) opened in 1954. These works are now developing rapidly with the expansion of the market for thin, flat products. Crude steel output at Serémange attained 1,411,000 tons in 1959 and it is here that the pure oxygen Kaldo process is to be installed to an ultimate capacity of $\frac{1}{2}$ million tons. Serémange has its own oxygen factory, greatly enlarged in 1959. A major extension of the Ebange cold strip mill is planned for 1962/3. Exceptional expansion is also occurring at the Jœuf works in the Orne valley where the largest blast furnace in France is to be blown in during 1961 and pig iron capacity will be ultimately raised to 2 million tons. Iron and steel works throughout the Moselle district are now supplied with oxygen through 40 kilometres of underground pipes (the "Oxylor" network, Fig. 2) from a factory at Richemont opened in May 1960. Richemont, at the confluence of the Orne and Moselle, is the site of another "collective" facility, the giant power station opened in 1955 linked by gas pipe and cable to Moselle district works. The twin plants, at the most central available site for serving the three valleys, symbolize important new economies in the spatial concentration of iron and steel works. The impending opening of navigation on the Moselle to Rhine barges from Metz to Koblenz, now anticipated in 1963, should add to the advantages of the Moselle district especially. Three works enjoy canal-side sites while others have near access to various port facilities located between Richemont and Thionville.

Steel markets

Partly as a result of the new strength of the French economy, partly as a result of improved technology and fuel supply, Lorraine steel is proving highly competitive within the European Coal and Steel Community. From 1956 to 1959 the Lorraine industry's share in the market for rolled steel products rose from 26 per cent to 34 per cent of deliveries in the Saar, from 3 per cent to 9 per cent in South Germany, from 3 per cent to 6 per cent in the Rhineland-Palatinate and Hesse and from 2 per cent to 5 per cent in Belgium.

London School of Economics

J. E. MARTIN

THE NEW RAILWAY AND PORT IN NORTHERN ECUADOR

Potential agricultural development in Ecuador lies in the lowlands, rather than in the Sierra, where there is considerable population pressure on suitable land. Although the development of the lowlands east of the Andes is hindered by their isolation and inadequate transport, the western lowlands, with only 10 per cent cultivated, are accessible to export markets by sea, and much of the underpopulated forest country has been proved suitable for commercial agriculture. In the late 1940s the banana became the boom crop in these coastal lowlands and since 1952 Ecuador has led the world in banana exports. The main areas of banana production have been in the central and southern lowlands where adequate transport is available. Bananas are grown near the ports of Esmeraldas and Puerto Bolívar and inland around Quevedo and Santo Domingo, which are linked by road to

the ports of Guayaquil and Esmeraldas respectively. With the completion of the Ibarra-San Lorenzo railway and the opening of port facilities at San Lorenzo, larger-scale banana production in northern Ecuador is now possible. Previously limited banana production close to San Lorenzo was marketed by canoe at Limones.

As early as 1926 the Guayaquil-Quito railway had been extended to Ibarra and it was planned to build a line west to Esmeraldas. Later, however, San Lorenzo, 60 miles northeast of Esmeraldas, proved to be a more suitable railhead port. About 30 miles of track northwest of Ibarra had been completed when the Second World War interrupted construction. In 1952 a French company, *Compagnie Industrielle et Agricole de Ventes à l'Etranger*, received the contract to build the remaining 94 miles of railway which were completed in 1957. Like many other modern transport links in South America, the line follows an old route between the Sierra and the coast. The single track has lay-bys for passing. In August 1960 there were two mixed freight and passenger trains in either direction each week. These took about 10-12 hours. There were also daily autocarrils (converted diesel buses) which, though more expensive, took only six hours for the journey.

At 7300 feet, Ibarra is in one of the lowest of the inter-Andean basins of Ecuador. Even sugar cane is grown, while wheat, maize and barley are common and some well-watered *haciendas* specialize in dairying. Northwards along the railway some twenty miles from Ibarra, near Salinas, it is extremely dry but sugar cane and some cotton are grown under irrigation and there is dairy production. Northwest of Salinas the railway enters rugged, barren terrain following the gorge of the Río Mira, and emerges on the western flanks of the Andes. Damper than the inter-Andean basin, the grass and bushes provide good grazing for cattle. As the railway descends from the steep mountainside into undulating foothills, forest replaces the grasslands. Although the forest contains valuable timber, most of the soil is poor and sandy. Indeed, apart from several mature banana plantations in the higher foothills, there is little cultivation. Settlement is extremely sporadic and many colonists have barely begun clearing. According to a United Nations survey, land within 25 miles of the coast is more fertile. Certainly settlement is denser in the plain and there are small villages, some of which are co-operatives. Within several miles of San Lorenzo all the land has been allocated but much is still not cleared. Here holdings consist of narrow strips running back into the forest from the railway but further inland plots seem irregular in size and shape.

All business concerning the railway is dealt with by a government agency, the Junta del Ferrocarril del Norte, not by the Government of Ecuador directly. Colonization along the railway is organized by the Junta, which also runs an experimental farm near San Lorenzo. In Ecuador unsettled land is national property and settlers usually obtain land free. Where an area has been designated for development and communications are provided, as in the Santo Domingo area and along the railway, colonists pay for their holdings. The sum is small and, as the only implements required by the prospective colonist are an axe and a machete, he needs little capital. Moreover, as the herbaceous banana is quick-growing the land yields a quick return. To obtain permanent rights to his holding, however, the settler must cultivate 25 per cent of it within five years. Eager for the best available

land, some settlers obtained their holdings before the port at San Lorenzo was completed, and had to cultivate their land without an export outlet for their crop. Because the local price of bananas is very low, they would have been in financial difficulties had the construction of the pier not provided employment and a market for the timber felled during clearing.

Most colonists are negroes, who form 8 per cent of Ecuador's population and have settled along the coast, particularly around Esmeraldas. A few are of mixed blood, but Sierra-born Indians are rare—they are too conservative to leave their traditional environment. The large estates in the upper foothills seem to be managed by wealthy whites.

San Lorenzo itself, once a fishing village, is now a boom town. There has been a vast influx of labourers, mostly negroes from Esmeraldas, who do construction work for ready cash but are reluctant to colonize. With its thatched houses, coconut palms and negro population, San Lorenzo is African in character. As in most of Ecuador, there is electricity but water supplies are poor. The town is low lying and the water brackish at high tide. Forest clearance has caused an enormous increase in mosquitoes. Apart from construction there are few employment opportunities. The régime of the two saw-mills closely reflects the demand for constructional timber. The small shrimp factory has a jetty for steam trawlers, and fishing from dug-out canoes is widespread.

Beyond the town there are no roads, but there is a small airstrip. Apart from the railway, the only regular form of public transport is a weekly boat service to and from Esmeraldas. The railway runs right to the pier to facilitate the loading and unloading of ships. In August 1960, the pier was still being extended but was scheduled for completion in October 1960. The water off the pier will have a depth of seven metres and two moderately sized banana boats will be able to load directly alongside simultaneously—unique at present in Ecuador. In a few years it is planned to build a second pier, immediately to the south, to accommodate really large vessels. Elsewhere harbours are shallow and lighters are used. This involves additional handling and expense. Moreover, San Lorenzo is about 400 miles nearer the Panama Canal than Guayaquil, Ecuador's main port, and the export of bananas from San Lorenzo should be quicker and cheaper. This should be most important in the fairly short voyage to the United States, which takes two-thirds of Ecuador's bananas. It will be less significant in the longer voyage to Europe. Unlike Esmeraldas, San Lorenzo, surrounded by mangrove swamps, has no silting problem.

The site of San Lorenzo has considerable natural advantages. Connected by rail to Quito, it could form an important port for Sierran exports and imports. The completed communications should enable the northern lowlands, still in a pioneer stage of development, to progress more rapidly.

London School of Economics

A. M. S. GRAHAM and D. A. PRESTON

THE DEVELOPMENT OF PORT KEMBLA, N.S.W.

The use of Port Kembla as a port, some 45 miles south of Sydney, began in 1883 with the shipping of coal from the Illawarra Field. Prior to this date coal had been shipped through Wollongong which was abandoned for the advantage of deep water at Port Kembla. The latter was an open roadstead,

offering little natural shelter for shipping, but in 1901 the construction of two protecting breakwaters was commenced.

The availability of good quality coking coal nearby attracted certain secondary industries to the area. In 1908 a custom copper smelter began operation and a processing plant followed. In 1921 a superphosphate and sulphuric acid plant opened. The present major industrial enterprise of the area, the iron and steel industry, was established in 1928.

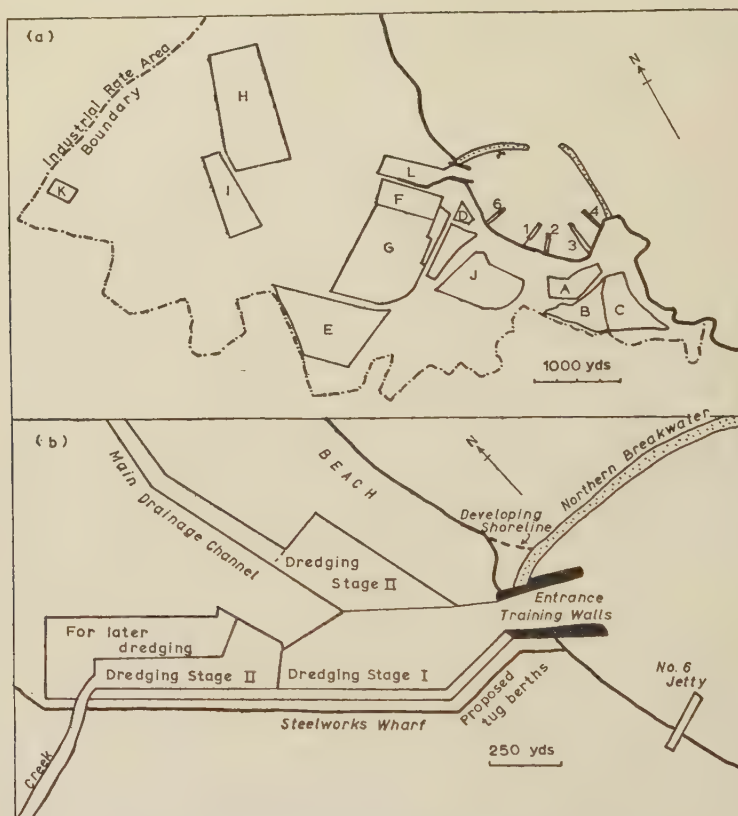


Fig. 1.—Port Kembla. (a) Major industries in the Industrial Rate Area: A, Fertilizer works; B, Copper smelting and refining; C, Copper manufacturing; D, Petroleum storage; E, No. 1 Steelworks; F, No. 2 Steelworks; G, Coke ovens and by-products plant; H, Steel-rolling mill (flat products); I and J, Steel-rolling mills; K, Stainless steel mill; L, Inner harbour area. Jetty locations in the Outer Harbour are numbered. (b) Inner Harbour Project: the area crossed by the main drainage channel is reserved for further development works.

The industrial development of the area was accompanied by additions to the facilities of the port. A general-purpose jetty (No. 4 in Fig. 1a) was built in 1908, and in 1915 a conveyor type of coal-loading jetty (No. 1) replaced the high-level jetty built in the 1880s. Equipment for the bulk handling of the iron and steel raw materials was installed in the harbour (No. 2 jetty) in 1928. Later major developments in port facilities consisted of the renewal of a general-purpose jetty (No. 3) in 1940, and of the construction in 1939

of an Inflammable Liquids Berth (on the northern breakwater) designed for the bulk discharge of petroleum products and fuel oil bunkering of vessels.

By 1949-50 the trade of the port (1,515,484 tons, cf. Sydney 8,294,861 tons) had recovered from war-time disruption. A decade later, however, trade had grown to 5,163,314 tons, an increase attributable directly to the local industrial expansion, and its manufacturing requirements and exports. During 1956 the port facilities were extended to the limit, and since that time the handling of larger tonnages has led to increased difficulties of port operation. The problems of coping with expanding trade have been heightened by the post-war increase in vessel size, requiring longer berths and slowing up ship turn-round times.

Two main lines of action have been taken, in recent years, to improve the port's capacity to handle cargoes. A four-berth jetty (No. 6) for general purposes was begun in 1958 and completed in 1960, the berths being put into use as they were progressively completed in order that the strain on existing facilities should be relieved.

The decision was also made by the N.S.W. Government to start work on a long-discussed plan to construct an inner harbour in the lagoon adjacent to the present outer harbour (Fig. 1b). The outer harbour does not offer complete protection for shipping on all days of the year, since it is subject to the action of waves causing surge and range conditions on at least ten days per year, with longer periods of the disruption of cargo handling. The expenditure required for an outer harbour expansion, however, approximates that for the inner harbour project, but such expenditure would have failed to secure safe conditions that the inner harbour could offer. Moreover, because of the local significance of the steelworks, the development of port facilities must inevitably be closely related to this industry, which was particularly anxious to have a wharf fronting its No. 2 plant.

The inner harbour scheme is ambitious but it recognizes the growth-potential of the port since provision is made for the construction of several inner basins at future stages. The first stage (part 1 of which has been completed) required dredging a space for a ship-swinging area and the first basin, where the two berths of the steelworks frontage were constructed. In the second part of this stage the extension of this wharf will bound on the west the completed basin. Stage II provides four berths to be built by the steelworks and five general-purpose berths to be built by the State.

No. 2 steelworks has as its focal point the inner harbour wharf front with its ore-unloading equipment, adjacent to the screening and sinter plant, and its steel-loading equipment on the "finished product" berth. The inner harbour wharves are the means whereby a dependence on outmoded outer harbour facilities can be avoided. As evidence of the shortcomings of these facilities it might be noted that No. 2 jetty, for example, is served by an inefficient shuttle rail service. Its rate of ore-unloading is slow; draft is restricted; and it is now placed too far from the ore-treating plants.

The coal-loading jetty is an even worse case; the plant neither handles enough coal per hour, nor operates efficiently. Recent increases in coal exports to Japan have placed great stress on the No. 1 jetty facilities and revealed clearly the problems of draft limitation (30 feet) and lack of storage space adjacent to the jetty. In fact, the railway acts as both the main medium of transport from colliery to the port and as a storage reservoir.

Hopes for a modern coal loader in stage I of the inner harbour are well founded.

The inner harbour scheme at Port Kembla has had two main results: it has allowed an integrated planning of the development of the steelworks and the port, and it has also suggested the possibility of the port becoming economically tied to a more extensive and productive hinterland. Port authorities and others maintain that pastoral and agricultural commodities originating in the south of N.S.W. could be funnelled through Port Kembla. It is feasible, therefore, that the port may diversify its functions by adding to the cargo flows from its industrial hinterland the movement of other products from a far larger area.

University of Melbourne

J. N. H. BRITTON

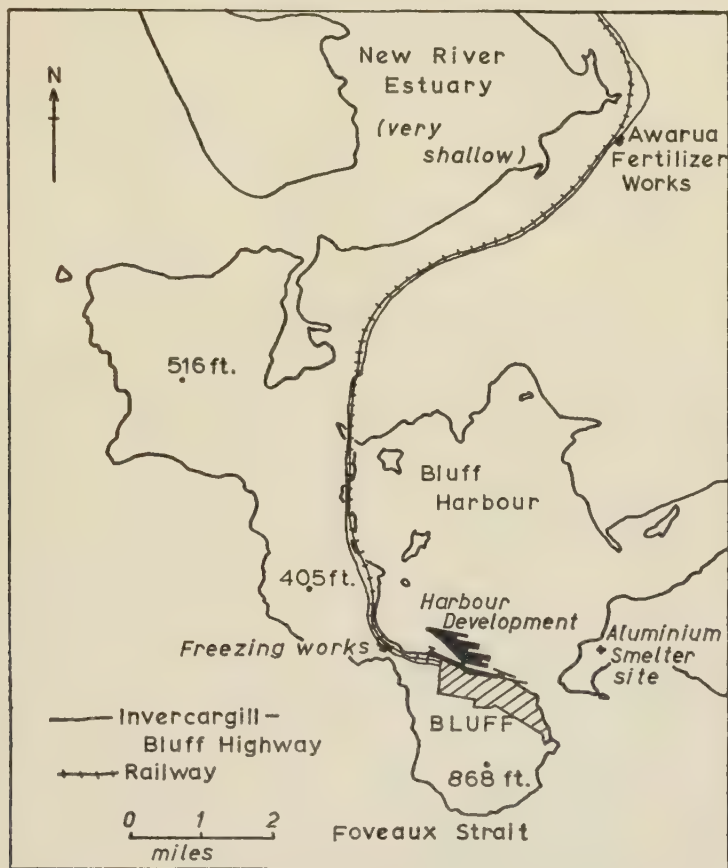
DEVELOPMENTS IN SOUTHLAND, NEW ZEALAND. THE PORT OF BLUFF

There has been in recent years a remarkable expansion in the sheep population of the Southland Land District, with a corresponding increase in meat and wool production. This, with other developments, has necessitated the striking improvements recently completed in the port of Bluff. Bluff (1960 population, 3240) has for long been a small port situated at the tip of a seven-mile long peninsula. It is the main fishing port for the southern part of New Zealand, specializing in oystering and crayfishing (Foveaux Strait has the largest-known natural beds of mud oysters—*ostrea sinuata*—in the world). Its natural harbour is a tidal lagoon, flanked to the south and west by low volcanic hills which reach nearly 900 feet by the harbour entrance and which shelter the port from the prevailing southwesterly winds and the strong currents of Foveaux Strait. The narrow entrance is kept well scoured by the tidal flow which reaches seven knots at spring tides. Off Bluff itself, on the other side of a channel leading to the port, was a sandbank just visible at low tide; this has been transformed into an island equipped with new port facilities, to meet Southland's rapidly growing needs.

An official survey in 1952 showed clearly the need for more berthage and led to the decision to create it on the sandbank as site conditions made it impossible to extend the existing accommodation. The trade of Southland has since increased to such an extent that Bluff is now the third exporting port in the Dominion, after Auckland and Wellington. An indication of the expansion of Southland's production is seen in the fact that its freezing works killed nearly three times as many sheep and lambs in 1959 as they had done in 1939 (1939, 1.4 million; 1959, 3.9 million). Regarding exports, since 1952 frozen meat increased by 10,000 tons to 60,000 tons in 1958-9 (15 per cent of New Zealand's total), and wool by 10,000 tons to 31,000 tons. Southland's fourth freezing works, large and with modern equipment, located just north of Invercargill and opened in 1960, has added to the tonnage of frozen meat handled. Official estimates suggest that within the next 30 years Bluff will become the largest frozen meat and wool exporting port of New Zealand. There has also been a great increase in some import tonnages, chiefly of bulk motor-fuels (1952-3, 10,000 tons; 1958-9, 78,000 tons) and of phosphate rock and sulphur (1952-3, 4500 tons; 1958-9, 45,000 tons) for the new fertilizer works at Awarua. Formerly, oil fuels

reached Southland mainly through the port of Otago; today, five major oil companies have large ocean depots at Bluff and this commodity is the largest one handled.

The northern part of the entrance channel has been widened and deepened to obtain a working draught of 33 feet. The sandbank has been developed into an 84-acre island retained on the western side by a rubble wall of



material quarried on Bluff Hill. Nearly 3 million cubic yards of dredged sand were used to raise the level of the sandbank 16 feet and to reclaim some 48 acres of foreshore. The map shows the five berths that have been made, arranged in line with the prevailing wind. The two smaller berths, 525 feet long, have been dredged to 26 feet and the three larger ones, 700 feet long, to 35 feet. There has been corresponding road, rail and transit shed development (incoming goods have hitherto been sent by rail to Invercargill for sorting). The improved transport facilities include railway marshalling yards on the western section of the island, a bridge to the mainland for road, rail and pedestrian traffic, and the reconstruction of the Invercargill-Bluff Highway. The berth at the northern end of the island has been equipped to provide all-weather meat-loading facilities; frozen meat from railway waggons is unloaded inside a shed built alongside the wharf apron, and

covered conveyers transfer the meat into the ships' holds. This allows vastly increased loading rates and speeds up the turn-round of ships. Minor changes include the transfer of the handling of the oyster catch to the south of the island and the concentration of bulk imports upon the former main wharf which is also available for general cargo in busy periods.

Of the greatest long-term importance to Southland is the vast and costly scheme, now in its earliest stages, to harness the power of Lake Manapouri for an aluminium project to be completed about 1966. The power, together with cheap brown coal from local mines, will be used at a smelter to be built near Tiwai Point. The provision of deep-water berthage for this undertaking will probably involve the formation of another island directly to serve the smelter. Besides further developing the port of Bluff, this project will help to increase Southland's population of 100,000 and add to the growing importance of Invercargill (population 40,000) as a regional centre.

Dunedin

MARION MCFARLANE

CONDITIONS AND TRENDS IN THE HIGH MOUNTAIN WATERSHEDS OF NEW ZEALAND

The extent, severity and diversity of soil conservation and erosion control problems in New Zealand have been stressed by many authors. Tremendous progress has been made over the past twenty years in combating erosion on the plains, in the valleys and on hill country—largely by control of rabbits, aerial topdressing and improved pasture management. But progress toward repair and better management of the mountain lands has been painfully slow despite the patent urgency of the matter, an urgency made evident by the expenditure of vast and increasing sums of money on downstream river control works.

The present condition of the mountain lands varies from excellent to very bad. In some regions the primitive dense mantle of forest, scrubland and grassland remains virtually intact. Despite torrential rainfall (in places 200–300 in. per annum and more), despite the precipitous topography, and despite the frequent extreme erodibility of both soils and bedrock, there is scant sign of abnormal erosion. In other regions the primitive plant cover has been destroyed and replaced by a poor, open, unstable assortment of introduced and native plants quite incapable of holding the soil or protecting the land against rain, wind and frost. In not a few instances the scene is as desolate as any in the Middle East. Steep torrents draining barren disintegrating mountain slopes spew immense loads of rock debris into the valleys and rivers.

In most cases the condition of the mountain watersheds lies between these extremes. There is immense variety in bedrock stability, in soil erodibility, in climatic factors conducive to erosion, in the ability of the vegetation to withstand fire and grazing, and in the history of land use and abuse. It is not permissible to generalize though it could be said that conditions are currently at their best in the high-rainfall hard-rock regions of the extreme southwest and northwest of the South Island and at their worst in the shattered indurated sandstone (greywacke) regions of eastern South Island. In the first case there is a negligible fire record, there has been no significant attempt at pastoral occupation, and introduced game animals are to some

extent held in check by a rigorous climate and the extremely difficult terrain. In the other case the fire record dates far back into pre-European times, much of the land has been heavily grazed by sheep for more than a century, game animals are not held in check by climate or terrain (though they may be by exhaustion of food), and the vegetation, subject to periodic drought, is far less capable of withstanding abuse. It is an unfortunate coincidence that many of the rivers of greatest importance, those flowing seaward across the most densely settled lowlands, are those rising in watersheds which are in bad order. Many if not most of the rivers draining watersheds in good order are of little economic importance.

There are good reasons for the comparative neglect of the mountain lands. Firstly, there has been intense and over-riding national preoccupation with the doorstep problems of the closely settled farmlands and with the immediate protection of towns and cities against flood. Secondly, there have been conflicts of opinion, not yet wholly settled, concerning the basic objectives of mountain land management—increased pastoral use and production, flood control or better regulation of the useful water yield, recreation through the hunting of introduced game animals, or, incompatibly, through enjoyment of a primitive undisturbed landscape, timber production, and so on. Not until these conflicts are resolved in the general acceptance of a sound concept of multiple use can real progress be made. Thirdly, the sheer physical difficulty of the mountain lands has been, and still remains, a grave barrier to progress. It is no accident that men, trained in New Zealand mountain country, have been outstanding in Himalayan and Antarctic exploration. The mountain lands of New Zealand are extensive, roughly one-half of the South Island and one-third of the North Island. Off the beaten track, and there are few beaten tracks, travel is difficult and slow. The river gorges are deep, the rivers unbridged and the weather unpredictable at all seasons of the year. There are few men who can live and work in these mountains with safety or for long enough to know them properly. And fourthly, largely a direct consequence of the foregoing, New Zealanders as a whole have little appreciation of their stake in the welfare of the mountain lands. Most New Zealanders look upon the mountains in much the same way as an Englishman looks upon the mountains of Switzerland: it is nice to have them there in the distance. It is not realized that everything that happens in those mountains, sooner or later, and to a greater or lesser extent, has repercussions on life in the lowlands. Popular support (and money) for action programmes will not be forthcoming to the extent necessary while this state of general ignorance prevails.

While the over-all picture is not a happy one there are some bright gleams on the horizon. There is a gradual awakening of public interest in the mountain lands, perhaps best expressed by a slow turning of attention on the part of local authorities away from engineering works for downstream river control towards control at source where the water falls. In regard to mountain lands in pastoral occupation there is great promise in recent research which has shown how, by correction of certain soil deficiencies, the best mountain land can be raised in productive value to the point at which it can absorb all the domestic animals that should be withdrawn from deteriorating high-altitude pastures. The way, therefore, is now part open towards realization

of a better and more permanent pattern of land use without injustice or economic hardship to land occupiers. The recent establishment of a Tussock Grasslands and Mountain Lands Institute, representative of all the most important Government agencies and economic interests concerned, and with, as first Director, a man widely experienced in agricultural education, should definitely promote the practical application of research findings.

The real hard core problem will then remain—the care and repair of mountain lands which are beyond the limits of pastoral occupation. In this field the New Zealand Forest Service is increasingly active, but the extent of the unoccupied mountain country is very great while the number of research and field workers available is small. The main task is control of introduced animals—deer of several species, chamois, Himalayan tahr, Australian opossums and wallabies, European hares, feral goats, pigs, etc. The native forests, scrublands and grasslands show no sign of being able to withstand continued use by these animals but control, apart from elimination, of them is difficult. Thirty years of costly hunting by professional riflemen has so far paid but slight dividends. Attention is more and more being directed towards poisons, a measure that presents major difficulties.

For repair of damaged watersheds it is becoming obvious that, in many important cases, it will be dangerous to rely on recovery of the native vegetation. Widespread use of introduced species from mountain lands overseas will probably be inevitable. Research on the introduction and acclimatization of potentially useful species has been initiated.

One thing is becoming increasingly clear: in its mountain lands, New Zealand faces a problem and a threat scarcely equalled in any other country. The erosion hazard is, perhaps, uniquely high, arising from a pernicious combination of precipitous topography, shattered or weak bed-rock, weak infertile soils of low erosion resistance, and violent climate, coupled with a native plant cover incapable of sustaining even moderate animal use.

*New Zealand Forest Service,
Forest and Range Experiment Station,
Rangiora.*

J. T. HOLLOWAY

A Sixth-Form Geography Conference

A REPORT

On Friday, 3rd February, 1961, a Sixth-Form Geography Conference was held at Canon Slade Grammar School, Bolton. The conference was organized by the Bolton Branch of the Geographical Association and was attended by 250 sixth-formers from 30 grammar schools in south Lancashire. It lasted from 4.30 p.m. to 9.30 p.m.

An introductory lecture, "The Economic Geography of Australia", was given by Dr. J. S. Duncan of the University of Manchester, who was called upon at very short notice owing to the unavoidable absence through illness of

Professor R. O. Buchanan of the London School of Economics. Dr. Duncan had recently returned from a sabbatical year spent mostly in Australia and had many new and excellent colour transparencies with which to illustrate his talk. He discussed the several types of pastoral farming, distinguishing between different kinds of sheep-farming; beef-cattle production; arable farming, mentioning the increasing rice-production in irrigated areas, viticulture and sugar-cane production; and the varieties of industrial production associated with Australia's mineral resources. In conclusion he pointed to Australia's basic problem, the fact that 80 per cent of the population is urban while the basis of the economy is rural. Vast areas of the "out-back" remain unsettled and have no prospect of being settled in the foreseeable future.

After this lecture, students were given the choice of attending any one of four lectures delivered simultaneously. In "Modern Developments in Geomorphology", Dr. R. Kay Gresswell, of the University of Liverpool, illustrated a few cases of geomorphological phenomena, using specific examples, and introducing his young audience to advanced concepts—and some controversies—by means of slides and discussion. Finally he illustrated the links between geomorphology, geology and economic geography by an analysis of the origins and constituents of soils in southwest Lancashire, an area known to most of the students.

Dr. J. I. Clarke, of the University of Durham, discussed some instances of "applied geography" in his lecture "Libyan Field Studies". Talking of an area which has apparently insoluble economic problems, he described the use of field work and survey in providing approaches towards the solution of the problems of pastoralism and irrigated agriculture amongst nomadic peoples in Libya.

Mr. J. P. Cole, of the University of Nottingham, spoke on "The Contemporary Urban Revolution". After drawing attention to different definitions of "urban", he discussed the economic changes which lead to urbanization and relevant problems of increasing world population.

The topic of Dr. E. Brooks, of the University of Liverpool, was "The Geographer and Regional Planning". He explained the need of the regional planner to apply his investigations and surveys to practical problems and mentioned the differences in criteria and techniques of regional planning both between pre-war and post-war British planning (drawing attention to failures in the Development Areas) and between Britain and other countries, such as the Netherlands and Poland where planning has to cope with geographical and social problems of local and individual character.

These lectures were followed by short (half-hour) papers read by seven sixth-formers who had volunteered to speak on some topic which they personally had investigated. Members of the conference were given the choice of hearing any one of the following papers:

"The pre-glacial Irwell at Kearsley" by W. K. Fletcher, Bolton School, Boys' Division.

"Field work in urban geography: a study of Lewes" by B. M. Heywood, Canon Slade Grammar School, Bolton.

"Field work in the Langdale valley" by M. Shufflebotham, Bolton School, Girls' Division.

"The farming problem in southeast Missouri: social consequences of economic advance" by R. S. Fleming, Wallasey Grammar School.

"Slopes" by I. R. Stone, William Hulme's Grammar School, Manchester.

"The Cairngorms" by I. Bilcliff, Hyde County Grammar School.

"Some physical features of south Shropshire" by P. Flynn, De La Salle College, Salford.

The students later returned to the groups in which they had heard the senior lecturers and, with sixth-formers acting as chairman and secretary of each group, proceeded to discuss the lecture they had heard. Finally the whole conference came together to take part in a General Assembly under the chairmanship of Mr. A. Rushton, President of the Geographical Association Bolton and District Branch, and with a panel composed of all the lecturers. The secretary of each discussion group delivered a short report of the lines of discussion and, in some cases, put a question to the panel on behalf of his group. Some of the questions put by the sixth-formers were:

Would the panel agree that in the study and teaching of geography the division between physical and human aspects of the subject is unnecessarily rigid? [The panel generally agreed that in the teaching of geography the subject should be treated as a whole.]

Geography has been said to be a study in areal differentiation. Which book or books exemplify this idea of the nature of geography and which book above all would each member of the panel consider to be an apt illustration of what geography is? [The panel expressed some disagreement with the description of the nature of geography as stated in the question before discussing books, of which special mention was made of *Géographie Universelle*, Preston James's *Latin America* (as a fine example of the art of regional geography in English) and H. J. Mackinder's *Britain and the British Seas*.]

Will increased efficiency in agriculture balance the increase in world urbanization?

Questions concerning the desirability of the introduction of Oriental immigrants into Australia; and the possibility of industrial development in north Africa on the basis of the recently discovered Saharan oil-fields.

What qualities would each member of the panel look for if he were interviewing a student who applied for entry to his department of geography? [In reply the lecturers would seek to discover evidence of intelligence, a lively curiosity, powers of observation, a genuine desire to go to a university and to learn and the ability to benefit from time spent at the university, interest and competence in geography but not specialized knowledge such as might have been gained by detailed teaching, a good record in subjects other than geography and of having read in the "fringe subjects" of geography. The applicant should have a genuine enthusiasm to read the subject and should realize that, just as "A" level differs from "O" level in G.C.E., so university work is very different from each of these.]

K. BRIGGS

The Geographical Association

PLAQUE TO SIR HALFORD J. MACKINDER

Sir Halford J. Mackinder was born in Gainsborough on 18th February, 1861. To commemorate the centenary of his birth a plaque was unveiled in the entrance hall of the Queen Elizabeth Grammar School, Gainsborough, by Professor S. H. Beaver, President of the Lincoln Branch of the Geographical Association, on 4th May, 1961. About 60 people were present, amongst them Dr. Hilda Ormsby, Professor K. C. Edwards, civic representatives of Gainsborough and district, the School Governors and Headmaster and members of the Lincoln and District Branch of the Association.

The plaque, in green Westmorland slate, presented by the Lincoln and District Branch, is the work of Mr. Leslie Atkinson, A.R.S.A., of Lincoln Training College.

SPRING CONFERENCE AT BRISTOL 1961

A great deal of hard work, done jointly by the Department of Geography of the University of Bristol and the Bristol Branch of the Geographical Association, produced a spring conference between 4th and 8th April that was both an enlightenment and an enjoyment for a large number of members. The Bristol area lends itself to a diversity of interest, whether in physical, historical, human or economic geography. It was especially pleasurable this year to have the practical assistance of a branch committee, several of whose members led excursions and introduced visiting teachers to their own "teaching ground". The production by the branch of a cyclostyled booklet of field-work methods and studies in different types of schools in the area was timely.

To Professor R. F. Peel, to the members of his staff in the Department of Geography and to the many outside speakers whom they enrolled to assist us, we are most grateful for a carefully planned programme, whose culminating "wine and cheese party" was a most enjoyable social conclusion. Our thanks go also to the University of Bristol, where we enjoyed excellent lecture and exhibition facilities and to Mr. J. Sloane, Warden of Wills Hall where most of the conference members lived. To the joint local organizers, Mr. L. F. Curtis and Mr. R. Kneeshaw, go the honours for the smooth running of the programme arrangements.

FOREIGN SUMMER SCHOOL 1962

Preliminary negotiations have been started towards the organization of a three-week course of varied types of field work in different areas to be held in western Norway in August 1962, under the direction of Professor Axel Sømme of the Norges Handelshøyskole, Bergen. It is expected that further details will be circulated to all members in November next, when registration for the course will be invited.

CHANGES IN SUBSCRIPTION RATES

The annual subscription for Student membership is now £1, for the period starting 1st September, 1961. This subscription entitles a full-time *bona fide* student in a university or a college, or a senior pupil in a secondary school either to receive *Geography* for the period or to use the library for the same period (or earlier if paid a short time in advance), but not to vote at an Annual General Meeting.

New categories of Corporate Membership have been introduced to be available to schools, colleges and libraries for the period starting 1st September, 1961. They are:

1. A college or school (in the United Kingdom) may subscribe on an annual payment of £4 to receive current issues of *Geography* and to have additional library

privileges (i.e. to borrow up to 6 books at one time, provided responsibility for loan requests and returns is taken by a head teacher, principal, teacher or lecturer. Library loans are restricted to the U.K.). The right to vote at Annual General Meetings is not included in this institutional membership, nor does it confer rights or privileges of membership upon individuals (lecturers or teachers) who must enrol under a form of personal membership should they wish to take part as members in Association activities.

2. A college, school or library may subscribe on an annual payment of £2 to receive current issues of *Geography* with no other privileges. This subscription is available to educational institutions both in the U.K. and abroad.

Details of these new subscription arrangements have already been sent to all student members and to schools, colleges and libraries who are subscribers through the Geographical Association.

ANNUAL SUBSCRIPTIONS

The renewal date for annual subscriptions for the period September 1961 to August 1962 is 1st September, 1961. The annual subscription for Full membership is £2. Notices and forms for renewal of subscriptions have already been circulated to members. Those who have not already renewed their subscriptions are urged to do so as soon as possible, returning the renewal form with the payment. The November 1961 issue of *Geography* will be supplied only on subscriptions recorded as renewed at the time of its circulation.

BRANCH NEWS

Attempts are being made to re-form a branch at Doncaster, where Mr. P. H. W. Alexander, 3 Belle Isle Drive, Wakefield, would be glad to have the names and addresses of members who are interested in taking part in branch activities in that district.

The Branches of the Geographical Association are now preparing their programmes for the coming session and members who are not already participating in these activities yet are within reach of centres where branches meet are invited to apply to local secretaries for the new programmes. Attempts to initiate branch activities in areas where they do not at present exist will be welcomed and every assistance will be given by headquarters office in this work. Members interested in starting a branch are invited to write to the Honorary Secretary.

The locations of branches of the Association and addresses of Honorary Secretaries are as follows:

Berkhamsted: Mr. G. F. B. Park, 1 Egerton Road, Berkhamsted, Herts.
 Birmingham: Miss P. A. Nicklin, 16 Middle Park Road, Selly Oak, Birmingham, 29.
 Blackpool: Mr. Bills, 138 Grasmere Road, Blackpool.
 Bolton: Mr. K. Briggs, 25 Southgrove Avenue, Bolton.
 Brighton: Mr. R. E. Metcalfe, 82 Western Road, Newhaven, Sussex.
 Bristol: Mr. R. Kneeshaw, 5 Northumberland Road, Redland, Bristol, 6.
 Cambridge: Miss S. M. Brazier, Homerton College, Cambridge.
 Carlisle and Cumberland: Mr. W. Batson, 104 Longlands Road North, Carlisle.
 Cornwall: Mr. J. B. Batten, 9 Higher Larrigan, Penzance.
 Coventry: Mr. P. D. Parr, 77 Weston Lane, Bulkington, near Nuneaton, Coventry.
 Crewe and Nantwich Branch: Mr. W. K. Smith, County Grammar School, Ruskin Road, Crewe.
 Derby: Mr. W. O. Butler, Derby School, King Street, Derby.
 Eastbourne: Miss R. Robson, Eastbourne High School, Eldon Road, Eastbourne.
 Edinburgh: Mr. R. G. Marr, 1 Easter Currie Crescent, Currie, Midlothian.
 S.W. Essex: Mr. D. Ferguson, 100 Essex Road, Romford, Essex.

Exeter: Mr. D. Morrish, St. Luke's College, Exeter.

Glasgow: Mr. J. R. Carson, 38 George Reith Avenue, Glasgow, W.2.

Goldsmiths' College Old Students: Miss B. Davies, Rowan County Secondary School for Girls, Rowan Road, Streatham, London, S.W.16.

Grimsby, Cleethorpes and District: Mr. J. B. Horwell, 26 Danesfield Avenue, Waltham, Grimsby.

Harrow and Wembley: Mr. J. Wightman, Parkfield House, Long Lane, Hillingdon, Uxbridge.

Huddersfield and Halifax: Miss D. Bairstow, 40 Bromley Road, Birkby, Huddersfield.

Hull: Mr. E. W. Hawcroft, 207 Victoria Avenue, Hull.

Ipswich: Mr. P. E. Underwood, Warrington House, 12 Warrington Road, Ipswich.

Northern Ireland: Mr. J. G. Cruikshank, Dept. of Geography, Queen's University, Belfast.

Isle of Thanet: Mr. A. P. Twigger, Green Dolphins, Camden Road, Broadstairs, Kent.

N.W. Kent: Mr. E. G. Firmin, 155 Upton Road, Bexleyheath, Kent.

Leeds: Miss E. Hall, Flat 24, Moor House, 19/22 Moorland Road, Leeds, 6.

Leicester: Mr. R. Millward, Dept. of Geography, The University, Leicester.

Lincoln: Miss E. J. Garlick, The Training College, Lincoln.

Liverpool: Mr. W. R. A. Ellis, 9 Shrewsbury Road, Wallasey, Cheshire.

Luton: Mr. A. D. Cooper, Luton College of Technology, Park Square, Luton.

Manchester: Mr. J. G. Durnall, 81 Queensway, Heald Green, Cheshire.

Medway Towns: Miss O. M. Williams, 19 First Avenue, Gillingham, Kent.

E. Middlesex: Mr. S. M. Beadle, 105 Green Dragon Lane, Winchmore Hill, London, N.21.

W. Middlesex: Mr. H. J. Savory, Borough Road College, Isleworth.

Newcastle: Mr. S. Hockey, Dept. of Education, 13 Leazes Terrace, Newcastle-on-Tyne, 1.

Norfolk: Mr. M. E. Ellson, Tiled Cottage, Pilson Green, South Walsham, Norwich, NOR 57Z.

Nottingham: Mr. A. J. Evans, 188 Woodborough Road, Nottingham.

Oxford: Mr. T. W. F. Allan, Southfields School, Oxford.

Plymouth: Mr. A. J. Lunnion, Devonport Boys Grammar School, Stoke, Plymouth.

Portsmouth and District: Mr. P. Thompson, Northern Boys Grammar School, Mayfield Road, North End, Portsmouth.

Reading: Miss B. S. Mason, 75 Albert Road, Caversham, Reading.

Sheffield and District: Miss W. M. Britton, 36 Chorley Drive, Sheffield, 10.

Shropshire: Mr. J. P. Dodd, Hampton Loade, Alveley, Bridgnorth.

Southampton: Mr. D. Petty, 43 Charmwen Crescent, West End, Southampton.

N. Staffordshire: Mr. J. E. Old, 26 Dilhorne Road, Forsbrook, near Blythe Bridge, Stoke-on-Trent.

Sunderland: Mr. D. B. Cowell, 8 Stannington Grove, Sunderland, Durham.

Swansea and District: Mr. J. Graham Jones, 143 Gower Road, Swansea.

Tees-side (Stockton): Mr. M. Bamlett, 14 Bentinck Road, Fairfield, Stockton-on-Tees.

N. Wales: Miss M. McCririck, St. Mary's College, Bangor, N. Wales.

S. Wales (East): Mr. F. T. Baber, 43 King George V Drive, Heath Park, Cardiff.

Winchester: Mr. M. Smith, 66 North Walls, Winchester.

Wolverhampton: Mr. K. C. Girkin, 71 Elizabeth Avenue, Goldthorn Hill, Wolverhampton.

Worcester: Mr. A. R. Wheeler, The Whiteladies, The Royal Grammar School, Worcester.

Worthing: Mr. A. H. Ridout, 92 Brighton Road, Worthing.

York: Mr. J. M. Jennings, Senior Common Room, St. John's College, York.

The West Middlesex Branch has published, as part of a local study project, three maps of its local area which are intended to provide schools working in the district with material based on sources which are normally scattered; their example and preparation could serve teachers in other areas with ideas on the development of local study work and cartography. The maps are 1. West Middlesex, relief and drainage (scale 1 : 25,000); 2. Heston, Isleworth and Twickenham in 1635 (scale 6 inches to one mile), plotted from information on the Moses Glover map of that year, now at Sion House; 3. Heston, Isleworth and Twickenham, 1800-1816 (6 inches to one mile). They may be purchased at 10s. each (cartridge paper) or 7s. 6d. each (dyeline prints) from the Secretary, Mr. H. J. Savory, Borough Road College, Isleworth, Middlesex, who can also supply notes on the maps.

WATER AND CONTOUR MAP PULLS: A SPECIAL SERVICE

Members are reminded of the existence of a special arrangement by which the Director of the Ordnance Survey allows the Association to purchase for its members "pulls" of maps at the scales One-inch to one mile, Quarter-inch and 1/25,000, showing water and contours only. These pulls are made only when the fully coloured sheet is being printed or reprinted and only when a member's order has been placed through the Association's office. Pulls are, therefore, not held in stock and cannot be supplied at short notice. These pulls are especially useful for local geomorphological, soil or location studies. Members who wish for further information about the service should apply to headquarters office for the leaflet on "Water and Contour Pulls".

SCHOOLS BROADCASTS

The following points are reported from a B.B.C. Press Conference on B.B.C. Sound and Television Broadcasts to Schools, 1961-2, as being of interest to geography teachers:

In future there will be a closer relationship between the pamphlets and the scripts of the lessons.

Special notes have been prepared for teachers. These are quite separate from the ordinary teaching pamphlets and should be ordered separately.

A special pamphlet, *Look, Listen and Teach*, has been prepared for University Departments of Education and Training Colleges.

It is now permitted to make tape recordings of lessons but these must be destroyed at the end of each term.

In the Spring Term of 1962 there will be a television series on the Geography of the United States of America. This will consist largely of film specially shot for the purpose.

In the Summer Term of 1962 there will be a television series on (i) climate and weather and (ii) landforms, erosion and weathering.

FIELD CENTRE NEAR INVERNESS

The University of Aberdeen as a Trustee for Tarradale House, Muir of Ord, near Inverness, once the home of Sir Roderick Murchison, founder of the Geological Survey, has opened the House as a field centre, able to take up to 30 persons and equipped with a small laboratory and a large library with lecture facilities. The centre will normally be open from March to October. Tarradale House lies east of Muir of Ord on the Fortrose road and offers facilities for reaching areas of geological, geomorphological, glacial, botanical and land-use interest. The west coast of Scotland can readily be reached on a day's excursion. Studies of the contrasts between the east and west Scottish Highlands and local studies of Inverness, Dingwall and Ullapool can be made. Requests for further information should be addressed to Professor A. C. O'Dell, Department of Geography, University of Aberdeen, Old Aberdeen.

Reviews of Books and Atlases

With very rare exceptions books reviewed in this journal may be borrowed from the Library by full members and student library members of the Association.

The Coastline of England and Wales in Pictures. J. A. Steers. 20 × 28.5 cm. 146 pp. Cambridge University Press. 1960. 30s.

One of the features of *The Coastline of England and Wales*, which for the past decade has been the leading reference work on the coast, was its fine collection of photographs. These pictures, together with many new oblique aerial photographs form the basis of this work. It would be difficult to find a more magnificent assemblage of coastal views and teachers will find this book a valuable aid. It is, however, a pity that none of the photographs gives any hint of the increasing despoliation of the coast.

One or two of the photographs have misleading titles. For example, No. 25, Old Harry Point shows neither Old Harry rock nor the "point", and No. 70, Steart Flats shows not these flats but Hinkley Point further to the west.

The format and the quality of photographic reproduction are excellent.

C. K.

The Mineral Wealth of Wales and its Exploitation. T. M. Thomas. 14.5 × 23 cm. xv + 248 pp. Edinburgh: Oliver & Boyd. 1961. 30s.

This is a very acceptable survey of Welsh mineral resources. Like other high-land regions, Wales has provided man with stone and metals in quantity for over five thousand years, but even so it is a revelation to find in this book their multifarious uses and working at the present time. Mr. Thomas treats in turn the provision of coal, slate, limestone, igneous rocks, sandstones, clays and other brick-making materials, refractories (silica rock, fire-clays, dolomite), sand and gravel, iron-ore, lead and zinc, gold, copper, manganese, and eleven miscellaneous deposits. He does not justify his choice of sequence; in general, it follows the order of production (1958), but on this reckoning slate and sand and gravel are out of their proper order. In each chapter the emphasis is on geological origins and conditions for working; there are forty-seven excellent distribution maps, those showing active production relating to June 1958. The photographs are carefully chosen and very striking, especially the air-photographs, e.g., the vertical picture of Halkyn Mountain (Flint) with its traces of early workings for lead and zinc. In view of the stress placed on the natural condition and current exploitation of minerals, their economic history, quite rightly, is kept to a severe minimum. But there are inconsistencies (e.g., a note on the "Past Mining Record" in the North Wales Coalfield, but nothing specifically on that in South Wales), and there are no references for readers wishing to know more of the background to the present picture. This can mislead on a local scale, e.g., no mention of lead mining at Bishopston in Gower, and haematite certainly was mined nearby at Oystermouth (p. 182).

At the national level, however, this will be indispensable as a work of reference in economic geology and geography. Mr. Thomas must be congratulated for compiling so much and presenting it so clearly.

F. V. E.

The Cardiff Region: A Survey. British Association for the Advancement of Science. J. F. Rees (Editor). 19 × 25.5 cm. xv + 222 pp. Cardiff: University of Wales Press. 1960. 21s.

Recent years have seen handsome and useful surveys prepared for the British Association, and the Cardiff volume is no exception. Accompanied by impressive photographs and instructive maps, the clearly written text will be of value to those

who wish to study the separate landscape elements of southeastern Wales. In addition, no one should overlook the splendid chapters on literary traditions, including an assessment of the regional novelists.

The section on landscape is of real worth. As in the careful chapter on geology (mainly stratigraphy), there is little discussion of geomorphological topics, but there are fine descriptions of the upland coalfield and the coastal levels. Little notice, however, is given here or in the disappointing chapters on economic activities to the contemporary industrial revolution which is reshaping the coastal flats.

The chapters on botany and zoology stress many relationships with the environment. The same geographical sense is not found in the chapters concerned with early history, where much repetition is also encountered (especially for the post-Roman centuries). The book would benefit from revision at several points, to remove such repetitions and to settle the contradictions, as over the historical importance of Cardiff—compare p. 92 and p. 111.

Perhaps the element most lacking is the integration of the various contributions. In addition to their factual content and handsome appearance, the British Association handbooks are now expected to be true regional surveys also. Unlike other university cities which have been hosts to recent Association meetings and where distinguished geographers were entrusted with forwarding the Surveys, Cardiff has no university geography department. Those geographers who look to the British Association for model regional treatments would be wise to choose other handbooks than this.

P. D. W.

The Soviet Union. The Land and its People. Geographies for Advanced Study. G. Jorré. Translated and revised by E. D. Laborde. 14.5 × 22 cm. xx + 372 pp. London: Longmans, Green & Co. Ltd. 2nd edition, 1961. 40s.

The spectacular changes in the Soviet economy during the last ten years and the writings of Berg and other Soviet geographers have inevitably made the English version (1950) of Georges Jorré's original work on the Soviet Union out of date. Chapters like "Conditions of Soviet agriculture on the eve of the German War of 1939-45" and "Transport and commerce on the eve of the German War of 1939-45" lacked a sequel. Jorré's death in 1957 prevented him from revising the book and the present second edition is the work of E. D. Laborde, who carried out the translation of the original French text with such consummate skill. Necessary changes and additions have been made to bring the book up to date so that once again it can claim to be one of the best descriptions of this "agricultural colossus" and "industrial giant" in the English language.

The book is divided into four parts. Part I surveys the physical milieu, with chapters on landforms, climate, soil, flora and fauna. The *merzlota* (permafrost) receives rather more mention in this second edition. The three chapters—ethnography, population, settlement—of part II cover the expansion of the Russian world from early times. Part III describes and analyses the Russian economic system. Advantage has been taken of a statistical abstract issued by the Soviet Union in 1957 (in which many tables give absolute figures instead of the percentages normally used) to transform this section completely. Part IV occupies rather less than half the book and contains sound, detailed and considerably revised regional descriptions of the Tundras, Forest Belt, Black Earth Country, Steppes, Desert Areas and their Mountain Fringe, and the Caucasus.

Statistics, generally up to 1955, are used lavishly and maps, diagrams and half-tone illustrations clarify the text. Two new maps (The *Merzlota* and The Arctic Islands) have been added, while those of the railways (now showing the important Ulan Ude-Ulan Bator-Peking; Urumchi-Hami-Lanchow; and Tayshet-Vitim—

Komsomolsk-Sovietskaya Gavan (B.A.M.) lines) and of airways have been redrawn. The utility of two other maps, Figs. 23 and 28, suffers from smallness of scale. The absence of a bibliography is unfortunate in view of the frequency of quotations from several unspecified sources.

In balance, objectivity, comprehensiveness, clarity and style this book is in the high traditions of the classical French geographers. It provides an up-to-date, informative and authoritative account of the Soviet Union, and for students of geography, whether in the sixth form, college or university, it forms a most valuable addition to the literature in English on that country.

G. M. H.

The Golodnaya Steppe and Prospects for its Reclamation. K. M. Dzhalilov. 17 × 24 cm. 30 pp. 1960 (1957). 14s. **Forest Resources of the U.S.S.R. and the World.** A. D. Bukshtynov. 22 × 27.5 cm. 65 pp. 1960 (1959). 18s. Both books translated from Russian and published for the National Science Foundation, Washington, D.C., and the Dept. of Agriculture, U.S.A., by the Israel Program for Scientific Translations, 14 Shammai Street, P.O.B. 7145, Jerusalem, Israel.

Another outlet in English for the increasing volume of technical Soviet literature is provided by the Israel Program for Scientific Translations on behalf of the United States' Department of Agriculture and the National Science Foundation. Of the 100-odd titles so far produced, none is specifically geographical, but several may be of interest to the practical geographer.

The first two numbers received are in marked contrast; the first is typical of the worst sort of Soviet semi-scientific publication; it has recently been almost entirely replaced by publications of the second type, which will command wide respect. *The Golodnaya Steppe and Prospects for its Reclamation* (Tashkent, 1957) makes no attempt either to give a detailed description of this limited area, or to draw general conclusions on the problems of irrigation in deserts. The style, at once peremptory and involved, is faithfully reproduced in translation. The text opens with a series of assertions on development projects which makes the ensuing description of natural conditions seem mildly irrelevant; of the latter, the climatic data are the most comprehensive, but the absence of maps and tables and of comparative statistics makes them of little value in gaining a representative impression. Early attempts at colonization are decried, while the success of Soviet efforts is "illustrated" by a mass of unco-ordinated statistical material on Stakhanovite earnings and percentage farm methods. Even the examples of increases in cotton yields in some localities at certain times lose much by the absence of any comparable data which might explain variations. The only significant pieces of information for the geographer are the admission that cotton yields on newly reclaimed land are lower than on the old, the call for agricultural diversification, and the denunciation of rice cultivation away from the riverine areas as a cause of salt concentration in the soil.

Forest Resources of the U.S.S.R. and the World (Moscow, 1959) is only two years later in time, but vastly superior in merit; the content is strictly factual, and little attempt is made to interpret the material; conclusions are mercifully left to the reader. The approach is painstaking, and the style neutral. Thirty-five pages are devoted to a detailed survey of species, reserves, and rates of growth in the U.S.S.R., and thirteen pages to a comparative study of the continents and selected countries. In addition to fourteen tables and seven pages of statistical appendix, the text is heavily loaded with numbers, some of geographical interest, others of more limited appeal. As a catalogue of resources the result is most comprehensive and should provide a valuable source of information for analysis. The geographer will note

with regret that there is no attempt at a systematic list of distribution and density of forest cover by oblast, state or province within the larger nations, and figures on the amount and purpose of the annual cut are few and incidental.

F. C. G.

Germany. T. H. Elkins. 12 × 19 cm. 272 pp. London: Christophers. 1960. 12s. 6d.

This is an excellent little book, designed particularly to meet the need for a work mid-way between the general text on Europe and advanced university texts. There are no pictures to distract the reader and raise costs, but plenty of maps and diagrams which are exceptionally clear and competent. The text is packed with information but nevertheless very easy to read, thanks to the author's avoidance of pedantry and jargon, and to his generally felicitous forms of expression.

The book, which covers both the German Federal Republic and the German Democratic Republic, is divided into two parts. The first opens with a clarification of terms relating to political and regional divisions of Germany, and a concise description of the physical background. This is followed by a comparatively full review of the evolution through history of the German peoples and states, and the significant features of the present-day economic geography of Germany as a whole. As a result of this mode of presentation the reader feels that he has acquired a far greater depth of understanding of a complex land and people than he can normally expect to do from a work of this size. Regional description which makes up the second half is on orthodox lines but also of high quality. The author has concentrated on significant differences between regions and adapted his mode of presentation to suit each region. By so doing he has kept repetition to a minimum and compressed a great deal of information into a very small space. Finally it may be noted that there are an efficient index and, after each chapter, suggested sources for further reading which are both in English and widely accessible. The whole work has been planned with discrimination and good taste.

A. J. H.

The Evolution of North America. P. B. King. 22 × 28.5 cm. xvii + 189 pp. Princeton: Princeton University Press. London: Oxford University Press. 1959. 60s.

The theme of this book is the geological evolution of the North American continent with particular reference to its structural pattern. It is not, as the author indicates in an excellent preface, a textbook and he attempts to illustrate various theories on continental structure by detailed consideration of certain areas. This, however, gives only a brief picture of a very useful and readable book. Although not comprehensive in its coverage the theme is laid down so well that it serves as an introduction to the geological evolution. The clear black-and-white diagrams and maps are relevant to the text and the style of writing, reflecting the basis of the book as a lecture series, is lucid and, in places, amusing.

This will obviously be of greatest use in university teaching for the geomorphologist and regional specialist of North America. The former will be rather disappointed in its restriction to structural aspects. Economic geographers may also find the detailed sections of value, e.g., in a consideration of mineral resources of the Canadian Shield and of Texas.

E. M. D.

The Discovery of the Pacific Islands. A. Sharp. 14.5 × 22.5 cm. xiii + 259 pp. Oxford: Clarendon Press. 1960. 45s.

It is difficult to judge the public for which this book is intended. One can well visualize the enthusiasm with which the author embarked on a research project of such an absorbing nature, but his objective is of limited interest save to those whose

life and interests are deeply concerned with these islands of Polynesia, Micronesia and Melanesia. Mr. Sharp set himself the task of identifying the islands visited and briefly described in the logs of 120 voyages from that of Magellan in 1520 to that of Hunter in 1835. He used modern hydrographic charts and authoritative printed sources of the logs and it is probable that the identifications are as reliable as will ever be established. The book consists of an introductory chapter dealing with his method and this is followed by 122 sections on voyages in chronological sequence, focused on the passages from the log books which described the islands seen or visited. The sections also summarize the ethnological data recorded by the discoverers. It will become a standard work for reference.

It is a pity that nowhere in this book is any attempt made to study the context and problems of Pacific exploration. In the section on Magellan the author states that he sought to establish a passage to the East Indies from the east and interested Charles I of Spain in his project. In fact Charles V of Spain sponsored this voyage, which was not "to the East Indies" for they were within the Portuguese sphere as established by the Treaty of Tordesillas in 1494 and Spain was excluded from them by that treaty. Magellan had two objectives for Spain: the first was to find a successful navigable route around South America by way of the Spanish sphere to the fabulously rich Spice Islands or the Moluccas; the second was to prove by his log that the Moluccas were in the Spanish, not the Portuguese sphere. It is astonishing that this work could have been written without mention of the Treaty or Meridians of Tordesillas which governed Portuguese and Spanish policy in their explorations in these parts of the world until 1560. The reviewer hesitates therefore to describe the book as scholarly in the full sense of the word, but has no doubt that it is highly successful in meeting its more limited objective.

A. D.

The White Road: A Survey of Polar Exploration from the Vikings to Fuchs. L. P. Kirwan. 14.5 × 22.5 cm. x + 374 pp. London: Hollis & Carter Ltd. 1959. 30s.

There are many histories of polar exploration but few as readable, as complete and as new in approach as this one by the Director of The Royal Geographical Society. Greek travellers, Irish monks, Viking homesteaders, Elizabethan adventurers, Dutch whalers, naval pioneers, international scientists follow each other in a rich chronology of human enterprise and endurance. The motives change through the ages from personal, economic, nationalistic, strategic to scientific. Recent extensive developments that follow the theme traced to the 1920s are summarized in final chapters with views on the place of polar regions in modern geography.

The bibliography and index enhance the value of the book as a reference tool, but more needy of attention, which may be given in reprinting, is the number of minor errors, though these detract but little from the fascinating story, most ably told.

H. L.

Principles of Physical Geography. F. J. Monkhouse. 14 × 22 cm. xxv + 511 pp. London: University of London Press Ltd. 4th edition, 1960. 30s.

This is a revised and enlarged edition of a widely used, sixth-form textbook which first appeared in 1954 (reviewed in *Geography*, vol. xl, p. 300). Amendments and additions to the text include new or more extended references to the age of rocks, pressure release as a weathering process, tors, river energy, glacial chronology, periglacial processes and effects, pediments, storm surges, air masses, frontal zones, thermal and lee depressions, tropical low-pressure systems and land classification. Chapter XI, "A classification of land-forms", is new, as are many of the 171 maps and diagrams and the 98 well-chosen photographs.

R. S. W.

An Outline of Geomorphology: The Physical Basis of Geography. University Geographical Series. S. W. Wooldridge and R. S. Morgan. 14 × 22.5 cm. xix + 409 pp. London: Longmans, Green & Co. Ltd. 1959. 32s.

This is the second edition of an extremely well-known textbook. There is very little change from the first edition and on the whole this can be applauded, a remarkable achievement when it is remembered that the first edition appeared almost a quarter of a century ago. The chapter on "The Geometrical Nature of Relief Forms" has been replaced by a brief chapter on the evolution of slopes, with a discussion of the views of Penck, L. C. King and Alan Wood. Some modification has been made on such topics as grade and glacial difference; for the rest, the book is essentially a reproduction of the first edition. To some extent more editorial correction was needed; present-day students will find it disconcerting to have a paper published in 1932 still referred to as "recent work", while the figures obtained by Wegener in 1932 are no longer "the latest figures for [the thickness of] the Greenland ice-sheet". The bibliographic notes appended to the book are very useful, although on p. 399 Pelher should be Peltier, and it seems doubtful whether Professor Linton has in fact written a paper on "Wakested Breaching by Ice".

K. M. C.

Physical Geography. A. N. Strahler. 2nd edition. 19 × 27 cm. vii + 534 pp. New York: John Wiley & Sons, Inc. London: Chapman & Hall Ltd. 1960. 60s.

This book is large, it is heavy, it is not very cheap. However, it must not simply be dismissed as yet another of those encyclopaedic American texts. It is true that it has the usual marks of the breed; glossy pages, photographs reproduced at a size proportional to their artistic quality rather than their geographical value and so on. It has, too, one particularly annoying and increasingly common feature, the use of large diagrams with little detail on them. Yet despite these disadvantages this is a useful text. Professor Strahler has much material to cover, but he has the space to be reasonably comprehensive and this makes the book useful for reference. There is also a lot of good material tucked away in the contoured maps that accompany the exercises at the end of many of the chapters; it is only a pity that these do not receive more comment. The text itself is rather difficult to read, the facts follow each other rather too fast, but there can be few who would want to sit down and read this sort of book right through. For school libraries in particular this offers the sort of attractive, background reference that can help to supplement the teaching of physical geography.

K. M. C.

The Earth Beneath the Sea. F. P. Shepard. 14 × 22 cm. xii + 275 pp. Baltimore: Johns Hopkins Press. London: Oxford University Press. 1959. 30s.

Oceanographical research has advanced so rapidly in the past decade that a readable account of its many different aspects such as Professor Shepard has provided in this book is a welcome addition to existing literature. As a practising oceanographer of long standing, the author has attempted to bring together his personal experiences and his unrivalled knowledge of the geology and morphology of the sea bed, and has produced a text remarkably free from technical jargon. For this reason it forms an admirable and up-to-date introduction to the subject for anyone wishing to learn more about the many aspects of study of the ocean floor. The early chapters deal with marine processes; they include an account of the great earthquake-generated sea wave in Lituya Bay, Alaska, the swash of which reached a height of 1700 feet above sea level on a spur at the head of the fjord. The remaining chapters deal successively with beaches, the continental shelf and slope and the deep ocean floor.

The book, although written for the layman, is not simply a diluted version of Professor Shepard's earlier work on *Submarine Geology* for it contains much that is new in the text and is amply illustrated by recent photographs and newly compiled maps.

A. H. W. R.

Coastal Changes. W. W. Williams. 14.5 × 22.5 cm. xviii + 220 pp. London: Routledge & Kegan Paul Ltd. 1960. 28s.

A book devoted to one aspect of coastal physiography is something of a rarity and one has to go back almost half a century to the publication of Sheppard's classic work on the lost towns of the Yorkshire coast to find the subject of coastal change treated in detail. The present book differs from its predecessor in that it is not limited to a single county and the author is able to draw on his own work, both in this country and the Mediterranean, for his examples. Its various chapters dealing with methods of observation, coastal processes, coastal form and sea defences all derive freshness from the personal approach adopted throughout the book. While many coastal physiographers will not readily agree with all the views expressed—for example, the attribution of coast erosion in Christchurch Bay largely to the effects of storm surges (pp. 147–8)—the book can be read with profit by all those who derive pleasure from the varied coastline of our islands.

A. H. W. R.

The Earth's Problem Climates. G. T. Trewartha. 17.5 × 25.5 cm. vi + 334 pp. Madison: University of Wisconsin Press. 1961. \$7.50.

While the theme of this book is the regional climates of the continents considered in turn, it is not a general regional climatology in the usual sense of the term. It is a supplement to rather than a replacement of the existing books of regional climatology. The great planetary controls of climate are sufficiently strong to produce broadly similar climates in similar latitudinal and continental positions. But while the general pattern of each continent's climate is in harmony with a recognizable world pattern, there are also notable regional departures from the expected arrangement or intensity. The study of these climatological anomalies is the main aim of Professor Trewartha's book, although the more usual climates are not entirely neglected.

The method of description and analysis is that of the dynamic climatologist using air masses, atmospheric perturbations and large-scale synoptic situations rather than averages of the climatic elements. For this the reader is assumed to possess a knowledge of meteorology and physical climatology which, as a whole, is equivalent to that of a first-year honours course in physical geography, although many sections should be capable of being understood by sixth-form students.

Of the 286 pages of description and analysis, 135 are devoted to tropical regions, 56 to Anglo-America and 20 to Western and Central Europe. In these areas, unusually high or low precipitations are the commonest topic of discussion. Such conditions are frequently associated with sparse settlement and inadequate climatological data but it is surprising that even in areas where records are adequate, no statistical tests of significance or dispersion about the mean are employed.

Production of the book is of the high standard one has come to expect of modern American texts, though closer editorial control might have been applied to the standardization of the numerous maps and diagrams, and the adoption of either the Fahrenheit or Centigrade scale throughout, and not a mixture of both.

A very copious bibliography completes the book which constitutes a valuable addition to climatological literature, though Professor Trewartha would be the first to agree that a great deal of work still remains before we fully understand these fascinating climatological enigmas.

T. J. C.

Weathercraft. Simple Experiments in Practical Meteorology. L. P. Smith. 16 × 22 cm. 86 pp. London: Blandford Press. 1960. 9s. 6d.

The book begins with an elementary non-technical survey of temperature, rain, wind and snow measurement, with sections on graphs, clouds and local forecasting. The style is "breezy", with very short chapters. There are many good photographs and diagrams which are new and should provide useful material for teachers, e.g., rain cumulative total graph, not just a histogram (bar graph). The second part is more detailed, covering microclimates, frost occurrence and forecasting, soil temperatures, horticulture under glass, transpiration and irrigation.

There are many useful "geographical vocabulary" features in the book, e.g., the equivalents of one inch of rain in snow, in tons per acre and in gallons per square yard. The approach is practical, therefore there is no mention of the weather chart and frontal theory and little on air pressure. There is an inconsistency between the popular style of the text and the unexplained use of words like "meniscus" and "transpiration".

Some of the experiments included are elementary, many are really suggestions for field work, some take months or years to complete, whilst others, e.g., on microclimates, are of advanced standard. Half of the book is more relevant to rural science than to school work in meteorology. The requirements for "O" level physical geography syllabuses, e.g., University of London, are not covered. The book is not suitable for class use but would be of interest in grammar school junior libraries and in secondary modern and technical schools, especially those with horticultural courses.

P. A.-J.

Erdkunde in Stichworten. Hirt's Stichwortbücher. 13 × 19 cm. 564 pp. Kiel: F. Hirt. 1961. DM26.40.

It is often convenient to teach systematic geography in class and make the pupils learn the facts for homework. This method justifies the publication of condensed books of sketch maps or books like this one which summarizes geography in note form. Even students for degrees can be seen conning them before examinations. This book is absolutely up-to-date, using, for instance, 1959 statistics for Russia, and is vouched for by half a dozen leading German geographers (including Kolb, Scheidl, Wilhelmy and Borchert) together with a Russian collaborator. The standard is about that of Ordinary level though the detail on Germany and Russia is fuller (27 pages on Russia and 80 on Germany). It is a stout and attractive volume of 564 pages, 180 red-and-black and 6 one-coloured maps, with 219 coloured illustrations, usually three a page. The maps are often systematic but some show detailed world distributions, regions, agriculture, glacial features, towns with a million people, railways and navigable rivers. A list, 31 pages long, of general and physical concepts is too brief an introduction. Man and economy is dealt with in 96 pages and here commodity distributions, exploration, an analysis of cultural realms (a particularly good feature) and good pictures of crops are the main contents. The 80 pages and 23 pictures devoted to Germany make it a very strong section. Maps of German village, house and town types are excellent. Europe, less Russia, receives 128 pages and 30 pictures. The British Isles section is of no value to us. Place names in eastern Europe are in the old German spellings and few double spellings are used. The small states of Europe come out best. Africa, Asia (including Russia) and Australia form another section. Only 2 sides are given to Japan and 5 to China. America receives 64 pages and 26 pictures and is especially accurate. Even contracted thus there is often space for such detailed information as that Kars was lost to Turkey at the end of the First World War. The colour pictures are as good as the price will allow and are clear and up-to-date, e.g., a *kolkhoz* in Mecklenburg. There is a good index, first of places and then of countries. A geographer

studying German would get a very adequate vocabulary of geography by reading this book.

D. J. D.

New Viewpoints in Geography. Twenty-ninth yearbook of the National Council for the Social Studies. Preston E. James, Editor. 15.5 × 23.5 cm. xi + 260 pp. Washington, D.C.: National Council for the Social Studies. 1959. \$5.00 (cloth), \$4.00 (paper).

The National Council for the Social Studies in U.S.A., founded in 1930, publishes yearbooks with particular themes; in 1959 the focus was on geography. For British geographers it is only fair to add that if the title had been "New Viewpoints in *American Geography*" they would not be disappointed by what is omitted. Thirty years is the span of time over which the survey has been made. In Britain, long before 1930, "geography's unique bridge-like relationship" between the natural sciences and the liberal arts was affirmed. More than 30 years ago teachers in Britain stressed the "why" of human activities and considered that geography was "a study of earth-man relationships within regions". For 40 years at least, they have wrangled over what constitutes a region; and decided that the umbrella term "geographical region" covered everything. The regions in chapter 6 are similar to those used by us.

In this book, the British reader will be surprised to see how small a contribution our European geographers have apparently made. Former giants, like Ratzel, von Humboldt, Ritter, Hettner and Vidal de la Blache are named; the work of H. J. Fleure and L. D. Stamp are casually mentioned; but where are de Martonne, Demangeon, Baulig, Blanchard, Herbertson, Roxby, Wooldridge, Linton and others? Is it true to say that in the last 20 years geographers have been more concerned with graphing statistics than with descriptive work? Is it necessary to reduce geographical concepts to algebraic formulae?

Some of the new viewpoints discussed in the yearbook are the work of L. C. King and T. J. D. Fair on Landscape Evolution; C. G. Rossby and J. Namias on the jet stream and atmospherical circulation. Approaches to Economic Geography are discussed under the macroscopic and microscopic. The latter with its emphasis on local conditions has been discussed in many geographical journals so the chapter deals with the "macro" approach which develops the theory of aggregate income determination. In Cartography, both American and British have made advances since 1940.

Chapter 8 is concerned with geographical concepts and generalizations which are taught as elementary social studies. In British primary schools, children enjoy descriptions of the work of the farmer, miner, postman; and listen avidly to accounts of the homes, food, games of the Lapp, Arab or negro child. They want to map what they observe and discover on the nature walk; and incidentally they learn also about the seasons, rain and sunshine, about mountains, valleys and the sea. By comparison, the statements made in the American programme (pp. 118-43) seem arid indeed.

A chapter is given to the teaching of social studies through "culture epochs". This is pure social history except for the mention of geographical locations. We may not agree with the seven listed in chapter 10: European, American, North African-S.E. Asian, Oriental, Soviet, African and Pacific. For 40 years in Europe geography has been taught out-of-doors in primary and secondary schools, in colleges and universities. We agree with the stress put on maps, globes and pictures in the classroom and with the teaching of physical geography; but think that if geography and history are taught separately by enthusiasts with integrity, a social studies programme is unnecessary. Finally, the general and specific requirements laid down for teachers of social studies are those required for teachers of geography and history

in Britain. The last chapter on the teaching of geography in the Soviet Union is interesting by contrast.

The book shows that much which we have taken for granted in geographical teaching is now becoming the accepted thing in America.

E. M. C.

Geography Rooms. Their Construction and Equipment. E. O. Giffard. 14 × 21.5 cm. 47 pp. London: George Philip & Son Ltd. 1961. 1s. 6d.

This booklet by the Educational Adviser to the publisher is very useful indeed and is well worth being placed in the hands of all those concerned with planning and equipping new schools or renovating old ones. Of necessity it follows largely the pattern of the booklet published by the Geographical Association in 1954; it deals with the same problems. It has, however, more illustrations of equipment and apparatus and of some newer geography rooms, including a good conversion from an older building. The booklet makes all the necessary points about the need for a large room, plenty of storage space, plenty of pin-up areas, good lighting and a good supply of apparatus for practical work, visual aids, etc.

One point which is omitted, surprisingly, is mention of the real need to have a hanging globe suspended so that it is correctly oriented if any real practical work with the sun is to be done—surely the space-minded geographer should know of this? Another sentence which raised the reviewer's eyebrows occurs on page 29 and states: "Looked at from the manufacturers' and suppliers' points of view instructional apparatus and instructional instruments are nuisances which have to be borne, rather than sources of pride and satisfaction." Now one knows why the plane table in one's school is both warped and rickety and cannot be used even to demonstrate the principles of plane tabling.

P. R. H.

ATLASES

Atlas of Economic Development. N. Ginsburg. University of Chicago, Department of Geography Research Paper No. 68. 35 × 24 cm. vii + 119 pp. Chicago: University of Chicago Press. 1961. \$5 (paper), \$7.50 (cloth).

There has long been a need for a well-organized map interpretation of statistical data relating to the growth and economic performance of different countries. The recognized techniques of pure economic analysis are inadequate and the additional use of mapping techniques reveals more of the nature of a given element, its regularity of occurrence and its relationships in space with other elements. More precise meaning is given to vague notions of "development" and "under-development", and it becomes possible to illustrate forcefully the fact that no two areas are identical in their problems or potentialities. This atlas thus makes a useful contribution to the great volume of published material on economic growth. Forty-eight world maps illustrate such elements as income; population growth, structure and organization; resource endowment; transport, and levels of technology and industrial development. Each variable is mapped according to a standard technique, which allocates each country to one of six groups—three above and three below a "world mean". This approach permits comparison, not measurement, but associated tables and text assist interpretation. The map legends, superficially complex, are soon mastered and an identical form is followed throughout. The use of national units as the basic geographical area, though amply justified in the introduction, has the obvious disadvantage of concealing major variations within large countries; while the scale of the maps (approx. 1100 miles to the inch) inevitably means much generalization

in areas like Western Europe. A population density map is overprinted on every map, adding, sometimes unnecessarily, to complexity, and a fold-out sheet might have been better. The fold-out principle has been used for a map of national product *per capita*, to permit easy comparisons—but is so arranged as to leave a foot or more between the maps compared. The Atlas could be usefully employed in sixth forms to produce a series of "country profiles" (an example is given for Ceylon). This could be a valuable exercise in itself, but also points the way for subsequent work. In general, however, the atlas provides a good starting point for further study by more advanced students, and a corrective to pure economic analysis—and this is perhaps a major function of a good work of this kind.

R. C. E.

Economic Atlas of the Soviet Union. G. Kish. 27 × 27 cm. 96 pp. Ann Arbor: University of Michigan Press. 1960. \$10.

This atlas comprises 64 diagrams of different parts of the USSR, showing agriculture, land use, mineral exploitation, industry and communications existing in 1960. The bibliography gives evidence of careful compilation but the remainder of the atlas fails to make the best use of the sources for many of the diagrams are confusing, misleading or uninformative. These deficiencies stem from an almost total failure to appreciate the cartographical problems which are involved in the production of thematic maps and the diagrams show interesting examples of elementary errors in presentation and design.

Two colours have been used throughout; the base plate, printed in brown, with thematic distributions usually printed in black. Area symbols have been selected from a range of Zip-a-Tone and allied patterns. The use of unsuitable designs (such as Zip-a-Tone 7 at approximately $\frac{1}{3}$ reduction) means that the individual elements of the patterns dominate the distribution which they are intended to depict. Few of the patterns used are suitable for illustrating the complex distributions of vegetation, agriculture and land use in Trans-Caucasia (Map 8A) or Southern Central Asia (Map 14A) and the difficulty of interpretation of these diagrams is further increased by the great thickness of much of the line detail.

The point symbols merely denote location and do not indicate capacity, volume of output or production. The symbols used are a pretentious collection of diagrammatic trucks, ingots, cog wheels and retorts. To facilitate recognition these symbols have to be large, some corresponding to distances of 50–100 miles at the scales of the individual diagrams. Moreover, to avoid illegible overcrowding, the individual symbols have to be more widely separated than is necessary with smaller and simpler forms of point symbol. Thus for a complex but comparatively isolated industrial town, such as Stalingrad, the relevant symbols occupy an area of about 5000 square miles of adjacent country. The use of the same symbols, at similar scales, for the representation of regions of more widespread industrial concentration (Donbass, or the vicinity of Moscow) implies that the diagrams of these areas are considerably more generalized than the others.

The part of each page which is not actually occupied by the diagram is diagonally ruled in brown, using a line gauge which is sufficiently obtrusive to be unpleasant. This feature of the general design has the effect of isolating each region as a unit which bears no discernible relationship to its neighbours. Apart from introducing a most unrealistic concept of regional geography, it results in some absurd examples of misrepresentation of communications. To quote only one example, on Map 10D, the Trans-Siberian railway is interrupted between Kurgan and Omsk in the section where the line passes for 100 miles or so through the Kazakh SSR.

This atlas cannot be recommended. It compares most unfavourably in content and cartographical standard with the *Oxford Regional Economic Atlas of the USSR and*

Eastern Europe (1955). The latter is sold at little more than one-half the cost of the work under review.

D. H. M.

Oxford Regional Economic Atlas. The Middle East and North Africa. Prepared by the Economist Intelligence Unit Limited and the Cartographic Department of the Clarendon Press. 19.5 × 26 cm. viii + 135 pp. London: Oxford University Press. 1960. 42s.

The arrangement of this atlas—general reference maps, topic maps, supplementary notes and statistics, and gazetteer—differs from that of its predecessor on the USSR and Eastern Europe by the separation of topic maps from statistical information. The imposing assemblage of data is of value to all interested in the Middle East and North Africa. On the other hand, while the maps are bold, attractive and make use in some cases of a wide colour range, in the eyes of the reviewer the atlas does not achieve the high standard of its predecessor. The first reason is the puzzling choice of countries. Surely it is difficult to justify the inclusion of Ethiopia and the Somalilands in this atlas, especially when a successor is to deal with Africa. This decision, along with the longitudinal extent of the whole region, means that nowhere in the atlas are there complete maps of Morocco and the Somali republic. Even more difficult to understand is the choice of scales for the reference maps. Despite desperate sorties over the margins, few of the reference maps fully satisfy their titles. It is also disappointing that no map of Libya is larger than 1 : 19 million.

The maps of geology, vegetation, soils and rainfall have an air of authority, although they are sometimes tentative through lack of adequate information. In northern Tripolitania, for example, the distributions of open Mediterranean maquis-forest and chestnut soils as well as the area with more than 10 inches of rainfall give a more favourable impression than reality. Furthermore, clarification of the 27 categories of vegetation would have proved helpful. The complete exclusion of Ethiopia and the Somalilands, where water-balance areas have a surprising distribution, might have simplified the drastically excised map of irrigation and water balance. On the other hand, the strip map of the Nile and that of the Tigris-Euphrates system are eminently useful.

Unfortunately many of the economic maps are marred, through no fault of the compilers, by spacious blanks separating crushes of detail; in some cases, larger scales of significant areas would have been preferable. One would have wished for more maps of the quality and character of that on the agriculture of the Sudan. They would have been possible for the whole of North Africa and the Levant, and would have been much more informative than the existing dot maps, some of which are of doubtful accuracy (e.g., p. 36 where the wheat and barley productions of central and southern Tunisia are unmarked, and where the northern limit of date production in North Africa is referred to as the southern limit). Further surprises are in the population map, especially the selection of tribal names, and in the map entitled "Historical Summary" which represents a strange number of "states usually independent" (e.g., Algeria and Fezzan) and "important provinces" (e.g., Tibesti, Senussi and Somali).

It is certainly unfair to emphasize the minor deficiencies of this atlas at the expense of its many good qualities, but they greatly detract from its reliability to either the scholar or the layman. Nevertheless, the atlas contains sufficient valuable information to ensure success as a reference work. One looks forward to a second edition.

J. I. C.

The Faber Atlas. Edited by D. J. Sinclair. 21.5 × 31 cm. 45 pp. Oxford: Geo Publishing Co. Ltd. London: Faber & Faber Ltd. 2nd edition, revised and enlarged. 1959. 36s.

When the Faber Atlas first appeared in 1956 it was rightly hailed as a new type of teaching atlas for use in British schools, universities and homes. Produced by

Verlag E. Hölzel in Vienna, it draws heavily upon other atlases of the same firm, although one of its greatest merits is that it is consciously presented for the British market. British teaching atlases had slipped behind their continental counterparts in content and design, and this infusion of continental cartography has proved most welcome. The success of the atlas is indicated by the considerable revision and enlargement for the second edition. Much of its success must surely be due not merely to the fact that the maps are colourful, bold and attractive, but also that they are designed especially for students of geography. Every effort is made to show diverse distributions, which are often presented in close proximity, inviting comparisons.

The atlas certainly lives up to Professor Stamp's laudatory Foreword, which acclaims the clarity of the colour printing, the use of layer colouring and hill-shading, the value of aerial photographs and town-plans as well as the frequent incorporation of maps of vegetation and land use, types of farming, geology, population and industries. It is particularly pleasing to note the profusion and orderly arrangement of general continental maps. Though some are small (e.g., 1 : 50 million to 1 : 100 million), they give the impression of careful compilation and drawing.

The most valuable sets of maps to the British student will probably be those of the British Isles (33 pages) and Europe (37 pages). Special mention should be made of (a) the general maps of the British Isles at 1 : 5 million showing counties, land use, types of farming, railways and navigation (why not roads?); (b) the selection of detailed maps at 1 : 200,000 including London and the major cities; and (c) the small maps which show types of farming and rural settlement. Among the maps of Europe are a selection at 1 : 200,000 of areas of special geographical interest, namely the Norwegian fjords, Elbe estuary, Austrian alps, Bosnian karst, Finnish lake plateau, Paris and Moscow. For the other continents (62 pages), scales exceeding 1 : 5 million are rare, and other distributions are preferred to large-scale physical maps.

Perhaps the least satisfactory maps are those depicting world climatic regions, population density, communications, economies and resources, where the scale of 1 : 200 million prohibits precision. The dot maps of resources, introduced in the second edition, are confusing at first sight as no numerical value is given to the dots, which are sometimes graded and sometimes not. Reference to inserted divided circles of world production by countries merely increases confusion. An example of these difficulties is seen in the map of lead ore and bauxite on p. 146 where comparison of the dots in Mexico and Australia may lead to false interpretation. It is felt that the simple major/minor classification of production centres or areas is inadequate for visual appreciation. A larger-scale map and a more realistic representation of values would greatly enhance these maps which do not quite attain the very high standard of the atlas as a whole.

In general, the *Faber Atlas* is first-class value, and may be recommended to geographers of all levels as the best atlas available at the price.

J. I. C.

MAPS AND MAP READING

The Ordnance Survey Annual Report 1959-60. 21.5 × 33 cm. 19 pp. 12 plates. London: H.M.S.O. 1960. 8s.

The present Report does not possess the interest of the previous issue for the non-specialist yet it is worthy of examination by sixth-form teachers: some of the paragraphs might well stimulate pupils to ask questions—perhaps some awkward ones! It will appeal to some as being suitable for the magazine table because of its indication of the enormous amount of scientific and technical work that is involved in mapping the changing face of Britain.

Ilfracombe and District. Ordnance Survey Sheet 856 (New Style)
1 : 25,000, covering 20×15 km. Chessington: Ordnance Survey. 1961.
 Paper folded 6s. 6d.; flat 6s.

The two attractions of this map are at once apparent when one considers that the standard 1 : 25,000 sheet covers but 10×10 km. and is priced at 5s. 6d. A note from the Ordnance Survey states: "Covering as it does a very popular holiday and walking area the map has been produced . . . as an experiment to test public reaction to these new features and the Department will welcome comments from users on the style of cover and size of the sheet." One of the features is the new type of cover of the folded map, formed by the folding of an extension of the paper of the map sheet instead of using cardboard, which innovation effects a reduction in production costs. It is to be hoped that the low price will be maintained, with resultant wide sales to justify the enterprise.

By virtue of its size the map now becomes a most useful aid to walkers and cyclists, giving, on a spacious sheet, the clarity of detail for which the $2\frac{1}{2}$ -inch map is notable. Two suggestions are offered. As this map seeks a wide public it would be an advantage to add road-gradient symbols; an indication of "single-track" lanes, if practicable, would be valuable for the forewarning of motorists and cyclists. One hopes also that members of the Geographical Association will respond to the invitation of the Survey for "comments from users".

Reading Topographical Maps. A. H. Meux. 19×26.5 cm. 84 pp.
 London: University of London Press. 1960. 10s. 6d.

The author has fully achieved his aim in writing "a teaching book which will enable any average student to analyse and understand most of what an Ordnance Survey map has to tell him". (This student, it would seem from the rate and standard of work tacitly expected, would be from the third year at least of the secondary course.) The result is the production of what can fairly be called an important step forward in the technique of teaching map reading. The book is physically well fitted for use in class sets, being strongly bound and very clearly printed on tough paper; further, all exercises are to be worked on separate paper. It is a work of marked originality, is eminently practical and has every sign of the application of teaching skill, experience and forethought.

The book provides a well-organized and fully integrated course, with many neat devices and a variety of types of exercise. It consists of a brief, concentrated introductory section of practical work on such basic topics as the National Grid, scale, gradient and so on, together with a rather tough introduction to the study of maps and photographs in combination. The main body of the course follows, consisting of a series of 16 study-topics covering the physical and human geography to be read from maps, for example, "Drainage systems", "Highland regions", "Distribution of land use". Finally, there are revision and advanced questions and an example of the use of maps in preparing for and carrying out field work. The special feature of the treatment of the study-topics is that each is based on a catechism, this being followed by explanation, an example of working, and graduated exercises.

Some examples of details are as follows: the photographs are printed with correct orientation in respect of the maps (an automatic corrective of the illusion that maps have "tops"); there is a grid-reference system for the photographs; landform diagram-maps are true, i.e., scale copies of portions of O.S. maps; there is a geological base-map for superimposition as a tracing.

Generously produced, with six full-page coloured map extracts at three scales, three characteristic sheets, fourteen photographs and with many line diagrams, this book is good value for money. The book is most strongly recommended to the notice of teachers in all types of secondary school.

Ordnance Survey Maps in Schools. H. W. Martin. 20 × 26 cm. 71 pp. London: Edward Arnold Ltd. 1960. 5s.

This well-produced textbook follows a well-worn track, one that has been trodden for some forty years. That is not to say that it can be dismissed out of hand. Full guidance and training are provided for the development of basic skills such as those relating to direction, scale, sections and interpolations in base-maps. There is a section on the ways of representing relief and summaries of the characteristic features and uses of the small- and medium-scale Ordnance Survey maps. Large maps (one-inch and 1 : 25,000) are provided for the eleven "regional" exercises; they are in black with blue for water. Much of the content of this course would be of value to more junior pupils who would, in due time, graduate to the standard of work required by the textbook by Meux reviewed above.

The author's declared objective—that of providing a course for secondary schools that is comprehensive—is not achieved. Specific and systematic help and practice in the recognition of the facts of physical and human geography that are read from maps are not given. There is no serious map-reading practice until p. 51 is reached. There is no Ordnance Survey map extract; and this is an omission for which no excuse can be accepted, so useful is such a map for constant and instant reference.

The small contoured map-diagrams on which the training in landform recognition almost entirely depends display very serious shortcomings. Not one of them appears to be a map of an actual existing feature, truthfully copied from an O.S. map, and six of them have gradients that belie their captions, given any reasonable scale. No scale is indicated.

F. J. C.

BOOKS AND PUBLICATIONS RECEIVED

- Geological Map Exercises.* B. Simpson. iv + 60 pp. London: G. Philip. 1960. 7s. 6d.
A Guide to Map Projections. R. E. Bowyer and G. A. German. 43 pp. London: Murray. 1958. 4s. 6d.
Power to Produce. Yearbook of Agriculture 1960. U.S. Dept. of Agriculture. xiii + 480 pp. Washington, D.C. 1960. \$2.25.
Field Work in the Bristol Area. Bristol Branch of the Geographical Association. (Cyclostyled.) 1961.
Surface and Rock-head Relief Features in the northern part of the Northumberland coalfield. W. W. Anson and J. I. Sharp. 24 pp. Department of Geography Research Series No. 2. University of Durham King's College, Newcastle-upon-Tyne. 1960. 5s.
An Atlas of Durham. H. Bowen-Jones (ed.). 28 pp. photographs, maps and text. Occasional Papers series No. 4. Department of Geography, Durham Colleges in the University of Durham. 1960. 5s.
Geologists' Association Guides. No. 32. Isle of Arran. S. I. Tomkeieff. 33 pp. Colchester: Benham & Co. Ltd. 1961. 3s.
Bibliography and Index of Geology and allied sciences for Wales and the Welsh Borders 1897–1958. D. A. Bassett. 376 pp. Cardiff: National Museum of Wales. 1961. 42s.
Western Europe. E. D. Laborde. xii + 292 pp. London: University of London Press. 3rd edn. (with revisions) 1961. 18s.
France. A Geographical Introduction. E. E. Evans. 192 pp. London: Chatto & Windus. New edn. 1959. 8s. 6d.
Zur Verwitterung, Bodenbildung und Morphologie der Keuper-Liaslandschaft bei Moutfort in Luxemburg. P. D. Jungerius. No. 2. Publicaties van het Fysisch-Geografisch Laboratorium, Universiteit van Amsterdam. 164 pp. In German; 8 pp. English summary. 1958.

- Vestlandet: Geographical Studies.* A. Sömme (ed.). Skrifter fra Norges Handelshøyskole Geogr. Avh. nr. 7. Prepared for the XIXth International Geographical Congress, 1960. English papers on Hardanger and Sogn; Forests in W. Norway; Møre-Ramsdal Coast; Espe-Maeland; Sörfjord; Ullensvang; Aga in Hardanger. Bergen: J. W. Eides Forlag. 1960. Kr. 18.
- Yugoslavia.* M. Heppell and F. B. Singleton. 236 pp. London: Ernest Benn. 1961. 27s. Historical survey.
- Siberian Arctic.* The Exploration and Development of the Kara Sea Route. J. Lied. 217 pp. London: Methuen. 1960. 30s.
- Nomads of South Persia.* F. Barth. Bulletin No. 8. Univ. Etnografiske Museum, University of Oslo. 159 pp. London: Allen & Unwin. 1961. 18s.
- The Ascent of Dhaulagiri.* M. Eiselin. 159 pp. London: Oxford University Press. 1961. 25s.
- Nepal. A cultural and physical geography.* P. P. Karan. 100 pp. Lexington: Univ. of Kentucky Press. 1960. \$10.
- The Tropical World.* P. Gourou. (Transl. E. D. Laborde.) 159 pp. London: Longmans. 3rd edn. revised, 1961. 21s.
- Melanesia. A short ethnography.* B. A. L. Cranstone. 115 pp. London: The British Museum. 1961. 7s. 6d.
- The Dawn of African History.* R. Oliver (ed.). 103 pp. London: Oxford Univ. Press. 1961. 10s. 6d.
- Nigerian Perspectives. An historical Anthology.* Selected by T. Hodgkin. 340 pp. London: Oxford Univ. Press. 1960. 30s.
- A History of Sierra Leone 1400-1787.* A. P. Kup. 211 pp. Cambridge: University Press. 1961. 21s.
- Tribal Maps of East Africa and Zanzibar.* J. E. Goldthorpe and F. B. Wilson. East African Studies No. 13. 14 pp. and 8 maps. Kampala: East African Institute of Social Research, P.O. Box 262, Kampala, Uganda. 1960. 7s. 6d.
- Multi-Racial South Africa. The Reconciliation of Forces.* Z. J. de Beer. Published for the Institute of Race Relations by Oxford University Press. 68 pp. London. 6s.
- McGill Sub-Arctic Research Papers*, Research Laboratory, McGill University, Montreal. No. 1. The Lichen Woodlands of the Knob Lake area of Quebec-Labrador, by E. M. Fraser. 1956. No. 6. Field Research in Labrador-Ungava. 1959. No. 7. The Bogs of Central Labrador-Ungava, by K. R. Allington. 1959. No. 9. Field Research in Labrador-Ungava (Annual Report 1958-59). 1960.
- No Latitude for Error.* E. Hillary. (Trans-antarctic Expedition.) 255 pp. London: Hodder & Stoughton. 1961. 21s.
- Antarctica. The Story of a Continent.* F. Debenham. 264 pp. London: Herbert Jenkins. 1959. 25s.
- My Polar Flights.* An account of the voyages of the airships Italia and Norge. U. Nobile. 288 pp. London: Muller. 1961. 25s.
- The Hakluyt Society Second Series.* Vol. cxi. English Privateering Voyages to the West Indies 1588-95. K. R. Andrews (ed.). 1959. 40s. Vol. cxii. The Tragic History of the Sea 1589-1622. C. R. Boxer (ed.). 1959. 40s. Vol. cxiii. The Troublesome Voyage of Capt. Edward Fenton 1582-83. E. G. R. Taylor (ed.). 1959. 35s. Vols. cxiv and cxv. The Prester John of the Indies. Vols. I and II. C. F. Beckingham and G. W. B. Huntingford (eds.). 1961. 35s. each.
- Model Making in Schools.* J. Eves. 113 pp. London: B. T. Batsford. 1961. 27s. 6d.
- Sample Studies in Geography.* A Bibliography. University of Southampton Institute of Education Library. 22 pp. 1s.
- Oxford Wall Maps.* Enlarged from Oxford atlases: British Isles; Western Europe; Eastern Europe; U.S.S.R.; Middle East, Pakistan and India; Far East; Australasia; North Africa; East Africa; Canada; U.S.A. and Central America; South America. 41 × 28 inches. Paper, fully coloured. 2s. 6d. each. Oxford University Press.

- Raw Materials of the World.* Wall chart 39 × 29 inches, issued by British Insurance Association, Barrington House, 59-67 Gresham Street, London, E.C.2. Free, with teachers' notes.
- Oil Milling. Essential Oils. Quick-Frozen Foods.* Revised editions of illustrated booklets issued by Education Section, Information Division, Unilever Ltd., Unilever House, Blackfriars, London, E.C.4.
- Bibliographie Géographique Internationale* 1958. International Geographical Union and Unesco. Paris: Centre National de la Recherche Scientifique. 1961. £2 8s.

Geographical Articles

Listed from Periodicals received in the Library

CONTINUED FROM VOL. XLVI, PP. 181 TO 184

Journals listed here may be borrowed from the Library by members of the Association in the British Isles. References are listed according to the classification published in the *Annals of the Association of American Geographers*, vol. xxvii, June, 1937. Authors' reprints presented to the Library are included in the list of articles. For abbreviations of titles of periodicals see *Geography*, vol. xlv, April 1961, p. 181. Abbreviations not included there are: A—Australian Geographer. BAGF—Bulletin de l'Association de Géographes Français. BE—Bulletin de la Société de Géographie d'Égypte. GB—Geographical Bulletin, Ottawa. GTD—Geografisk Tidsskrift (Denmark). IGJ—Indian Geographical Journal. LG—La Géographie (Belgium). MPG—Michigan Papers in Geography. NG—New Zealand Geographer. NGT—Norsk Geografisk Tidsskrift. OG—Oriental Geographer. PN—Problems of the North. RCG—Revue Canadienne de Géographie. RGA—Revue de Géographie Alpine. RGI—Rivista Geografica Italiana. SAJ—South African Geographical Journal. SGA—Svensk Geografisk Årsbok. T—Terra. WGS—Wiener Geographische Schriften.

(E)—English summary. (G)—German summary. *—Maps.

EUROPE. Physical. L. BAUER, BD, Vol. 25, Sept. '60.—Comparative hydrogeography of Thuringian rivers (in German). A. BERGDAHL, SGA, Vol. 35, '59.—Glacifluvial estuaries on the Närke Plain, Sweden. M. P. BIROT, BAGF, Nos. 286-7, Nov.-Dec. '59.—Reliefs de l'île de Crète (*). J. BLACHE, RGA, Vol. 48, No. 4, '60.—L'inversion du relief en Chartreuse, also—P. VEYRET, L'inversion du relief en Chartreuse: Précisions et compléments, and P. VEYRET, RGA, Vol. 48, No. 2, '60.—Le problème de l'inversion du relief en Chartreuse (et dans les Préalpes françaises du Nord). H. BOBEK, MW, Vol. 101, Pt. 1, '59.—Ice retreat in the Klagenfurt Basin (in German*). C. L. BONCAMBI, GNS, Vol. 4, July-Oct. '59.—Underground hydrology and Karst in the Apennines Umbro-Marchigiano (in Italian). L. BRAVARD, RGA, Vol. 48, No. 1, '60.—Morphologie glaciaire sur les Marges Orientales du Plateau de Chambaran (Bas-Dauphine). M. M.-M. CHARTIER, BAGF, Nos. 284-5, May-June '59.—Les eaux naturelles courantes du bassin de la Seine: intérêt géographique des mesures physico-chimiques et biologiques. M. A. CHOLLEY, BAGF, Nos. 283-9, Jan.-Feb. '60.—La structure et l'évolution morphologique du Bassin parisien. A. D'ARRIGO, GNS, Vol. 5, No. 4, '60.—Physiographic characteristics of the Italian coasts (in Italian). J. DEBELMAS, RGA, Vol. 48, No. 4, '60.—Genèse du relief subalpin. M. H. ELHAI, BAGF, Nos. 284-5, May-June, '59.—Morphologie littorale: Lingreville, un havre de la côte Ouest du Cotentin. P. V. FEDOROV and L. A. SKIBA, IANS, No. 4, '60.—Holocene levels of the Caspian and Black Sea basins (in Russian). H. FLUGEL, MW, Vol. 102, Pt. 1, '60.—Late-quaternary development of the Grazer Feld, Styria (in German). P. GABERT, RGA,

Vol. 48, No. 4, '60.—Erosion sur les massifs montagneux qui dominent la plaine du Pô. M. G. GALIBERT, BAGF, Nos. 290-1, March-Apr. '60.—Relief de Haute Montagne dans le massif de Zermatt (Alpes Valaisannes). K. GLEDITSCH, NGT, Vol. 17, Nos. 1-4, '59-60.—The highest mountains of North Norway (E*). A. A. GRIGOR'YEV and M. I. BUDYKO, SG, Vol. 1, May '60.—Classification of the climates of the U.S.S.R. (*). F. G. HANNELL and I. Y. ASHWELL, GJ, Vol. 125, Mar. '59.—Recession of an Icelandic glacier. L. HEMPEL, BD, Vol. 22, Mar. '59.—Geomorphological research in Germany (in German). C. G. HOLDAR, GA, Vol. 41, No. 4, '59.—Inland ice in the Abisko area, Sweden. G. HOPPE, GA, Vol. 41, No. 4, '59.—Glacial morphology and inland ice recession in Northern Sweden. INTERNATIONAL GEOGRAPHICAL UNION, F, Vol. 84, '60.—Coast and archipelago of Southwestern Finland. Guidebook to excursion E.F.1. M. I. IVERONOVA, IANS, No. 4, '60.—Surface run-off of rain and snow-melt waters on mountain slopes, Terskei Ala-Tau range (in Russian). G. JOHNSON, GA, Vol. 41, No. 1, '59.—True and false ice-wedges in southern Sweden. S. S. KORZHUEV, IANS, No. 4, '60.—Morphostructure and neo-tectonics of the Siberian platform (in Russian). I. LARSSON, SGA, Vol. 35, '59.—Tectonic conditions determining the supply of ground water in pre-Cambrian rocks in Sweden (in Swedish). R. LEBEAU, RGL, Vol. 34, No. 4, '59.—Contribution à la morphologie des Alpes Centrales. P. A. LETUNOV and others, SG, Vol. 1, Oct. '60.—Soils and bioclimatic regionalization of the U.S.S.R. E. LICHTENBERGER, MW, Vol. 101, No. 1, '59.—Retreat of the Würm glacier in the Central Klagenfurt Basin and the Krappfeld (in German*). J. M. NICHOLSON, TA, Vol. 1, Apr. '58.—Dry summers of Mediterranean regions. R. REPO, F, Vol. 84, '60.—Jaamankangas—an ice-marginal feature in Eastern Finland (*). J. ROUSSEAU, RGL, Vol. 35, No. 2, '60.—Statistique des types de temps de la région Lorraine. G. I. RYCHAGOV and O. K. LEONTIEV, IANS, No. 4, '60.—Relief evolution in the eastern part of north Caucasian Plains (in Russian). V. SCHYTT, GA, Vol. 41, No. 4, '59.—Glaciers of the Kebnekajse-Massif (*). R. SEIFFERT, Basler Beiträge zur Geogr. u. Ethn. Ergänz. zu Regio Basiliensis, Vol. 1, '60.—Zur geomorphologie des Calancales, Grisons, S. Switzerland (*). P. SITZMANN, RGA, Vol. 49, No. 1, '61.—Les variations récentes des glaciers du bassin de la Romanche, France. H. SPREITZER, MW, Vol. 102, Pt. 1, '60.—Geomorphology of the N. limestone Alps (in German). K. STRØM, NGT, Vol. 17, Pts. 1-4, '59-60.—The Norwegian coast. T. SUND, NGT, Vol. 17, Pts. 1-4, '59-60.—Fjord land and coast land of Western Norway. S. THORARINSSON and others, GA, Vol. 41, Nos. 2-3, '59.—Geology and geomorphology of Iceland (*). N. J. W. THROWER, A of G, Vol. 50, No. 1, '60.—Cyprus—a landform study. Map supplement number 1 (*). P. VEYRET, RGA, Vol. 48, No. 1, '60.—La tournée glaciologique de 1959. R. VIVIAN, RGA, Vol. 48, No. 2, '60.—Le recul récent des glaciers du Haut Arc et de la Haute Isère. R. G. WEST and B. W. SPARKS, Phil. Trans. Royal Soc. London, Series B. No. 701, Vol. 243, '60.—Coastal interglacial deposits of the English Channel. K. WICHE, MW, Vol. 101, Pt. 3, '59.—Geomorphological studies in southeast Spain, Murcia (in German). A. A. ZEMTSOV, IANS, No. 4, '60.—Deep-lying perennial frozen rocks in west Siberia (in Russian).

EUROPE. Cultural. A. AAGESEN, GTD, Vol. 59, '60.—Population of Denmark. P. M. ALAMPIYEV, IANS, No. 4, '60.—Division into economic regions in Lenin's works, and their practical performance (in Russian). P. M. ALAMPIYEV, SG, Vol. 1, Apr. '60.—Development of major economic-geographic regions, Russia. P. M. ALAMPIYEV, SG, Oct. '60.—Economic regionalization at the present stage (concerning Russia). M. ALLES-FRESDE, RGL, Vol. 35, No. 3, '60.—Villes Arctiques de la Norvège. D. L. ARMAND and others, SG, Vol. 1, June '60.—Geographers in the study, mapping, economic appraisal, utilisation, conservation and renewal of natural resources of U.S.S.R. P. ATTUONI, RGI, Vol. 66, Dec. '59.—New industrial centers in Latium, Italy (E). C. BERNARD, RGL, Vol. 35, No. 3, '60.—Problèmes de communications en Norvège du Nord. A. BERTIN, RGA, Vol. 48, No. 4, '60.—Barrage de Serre-Poncon (Durance). J. BIENFAIT, RGL, Vol. 36, No. 1, '61.—L'industrie française de la machine-outil. M. R. BLANCHARD, BAGF, Nos. 292-3, May-June '60.—Les traits physiques du site de Nice. E. BODZENTA, MW, Vol. 101, Pt. 3, '59.—Innsbruck. Eine sozial-ökologische Studie (*). J. BOICHARD, RGL, Vol. 35, No. 2, '60.—La modernisation agricole sur les plateaux du Jura. B. G. BONDARCHUK and others, SG, Vol. 2, Jan. '61.—Natural resources of the Ukrainian SSR and ways of using them rationally. P. S. BOYLE, RGA, Vol. 48, No. 3, '60.—Le nouveau port pétrolier de Lavéra: expansion portuaire de Marseille. M. S. BUYANOV-SKIY, SG, Vol. 1, Mar. '60.—Development of the Pechora coal basin, Russia. J. P. COLE, Bull. Material Geog. U.S.S.R., Univ. of Nottingham, No. 8, Aug. '60.—Nationalities of the U.S.S.R. in 1959. J. P. COLE, Bull. Material Geog. U.S.S.R., Univ. of Nottingham, No. 9, Aug. '60.—Soviet foreign trade. O. CONSTANTINI, MW, Vol. 101, Pt. 1, '59.—Electricity generation in the Volga region (in German). J. K. CRAIG, TA, Vol. 1, Apr. '60.—Vienna: a geographical analysis. F. F. DAVITAYA and others, SG, Vol. 1, June '60.—Climatic resources of the U.S.S.R. and their economic utilization. E. DEBRAZZI and A. G. SEGRE, RGI, Vol. 67, Mar. '60.—New maximum depth recorded in the Mediterranean Sea (in Italian). K. V. DOLGOPOLOV, SG, Vol. 1, Mar. '60.—Economic develop-

ment of the central Chernozem areas of the RSFSR. K.-G. FABER, BD, Vol. 22, Mar. '59.—Landscape of the Pfälzer Wald and its borders (in German). R. A. FRENCH, GJ, Vol. 127, June '61.—Geography and geographers in the Soviet Union. I. P. GERASIMOV, SG, Vol. 1, Jan.-Feb. '60.—Present status and aims of Soviet geography. E. T. GREENE, SR, Vol. 7, Dec. '59.—West German city reconstruction: Griechenmarkviertel in Cologne and Holtenauer Strasse in Kiel. A. A. GRIGORIEVA, IANS, No. 4, '60.—Industrial development of the Irkutsk economic administrative region (in Russian). N. A. GVOZDETSKLY, SG, Vol. 1, Nov. '60.—Physical-geographic regionalization of the U.S.S.R. for agricultural purposes. D. J. M. HOOSON, GJ, Vol. 126, June '60.—Middle Volga—an emerging focal region in the Soviet Union. B. S. HOYLE, RGL, Vol. 36, No. 2, '61.—L'industrie du raffinage pétrolier en France et en Grande-Bretagne. M. A. H. DE LEMPS, BAGF, Nos. 288-9, Jan.-Feb. '60.—Vignobles du Sud de la cuenca du Duero (Castile, Spain). I. HUSTICH, T., Vol. 72, No. 1, '60.—Finland in the world today (E). INTERNATIONAL GEOGRAPHICAL UNION, F, Vol. 84, '60.—Physical and human geography of Finnish Lapland. Guidebook to excursion E.F.2. INTERNATIONAL GEOGRAPHICAL UNION, F, Vol. 84, '60.—Regional geography of the Finnish Lake Plateau and of eastern Finland. Guidebook to excursion E.F.3. A. G. ISACHENKO, SG, Vol. 1, Apr. '60.—Landscape map of the northwest of the Russian Plain at 1 : 1,000,000. F. ISACHSEN, NGT, Vol. 7, Pts. 1-4, '59-'60.—Rural settlement in Norway. Excursion E.N.5, Bergen-Gudbrandsdal-Nordfjord-Bergen. V. V. KISTANOV, SG, Vol. 1, Apr. '60.—Economic regions in the eastern U.S.S.R. R. KLOPPER, BD, Vol. 23, June '59.—New major cities: Ludwigshafen-Leverkusen-Höchst (in German). I. V. KOMAR, SG, Vol. 1, Apr. '60.—Seven-year plan: The major economic-geographic regions of the U.S.S.R. I. V. KOMAR and others, SG, Vol. 1, Oct. '60.—Intra-Oblast regionalization. O. A. KONSTANTINOV, SG, Vol. 1, Sept. '60.—Cities and the urban population of the U.S.S.R. (1959 census). O. A. KONSTANTINOV, SG, Vol. 1, Sept. '60.—Economic-geographic studies on economic regionalization of the U.S.S.R. J. LABASSE, RGL, Vol. 36, No. 2, '61.—Structures et paysages nouveaux en Allemagne du Sud. M. LAFERRERE, RGL, Vol. 36, No. 2, '61.—La concentration industrielle lyonnaise (Saint-Fons). A. M. LAMBERT, EG, Vol. 37, Apr. '61.—Farm consolidation and improvement in the Netherlands (Land van Maas en Waal). S. LESZCZYCKI, GJ, Vol. 126, Dec. '60.—Application of geography in Poland. P. E. LYDOLPH and T. SHABAD, A of G, Vol. 50, Dec. '60.—Oil and gas industries in the U.S.S.R. V. H. MALMSTROM, A of G, Vol. 50, June '60.—Influence of the Arctic front on the climate and crops of Iceland. M. B. MASANOVA, SG, Vol. 1, Apr. '60.—Maritime transportation and economic-geographic regions of the U.S.S.R. E. MIGLIORINI, GNS, Vol. 5, Mar.-Apr. '60.—A scheme to submerge Mediterranean desert areas (in Italian). M. W. MIKESELL, GR, Vol. 50, Apr. '60.—Market centers of northeastern Spain. N. NIELSEN, GTD, Vol. 59, '60.—Greater Copenhagen. An urbanized area and its geographical environments. M. PALOMAKI, F, Vol. 84, '60.—Post-war pioneering in Finland with reference to the role of the settlement areas. W. H. PARKER, GJ, Vol. 126, Sept. '60.—Europe: How far? (*). V. V. POKSHISHEVSKIY, SG, Vol. 1, Sept. '60.—Population geography and economic regionalization of the U.S.S.R. M. I. POMUS, SG, Vol. 1, Jan.-Feb. '60.—Economic-geographic study of the cities of the U.S.S.R. N. J. G. POUNDS, EG, Vol. 36, July '60.—Industrial geography of modern Poland. J. RENUCCI, RGL, Vol. 36, No. 2, '61.—L'agriculture de la Corse. REVUE DE GEOGRAPHIE ALPINE, RGA, Vol. 48, No. 3, '60.—Bulletin bibliographique des Alpes françaises pour 1959. A. L. RODGERS, UCH, No. 66, '60.—Industrial geography of the Port of Genova. M. SAILER, WGS, No. 6, '59.—The Port of Vienna (E). Yu. G. SAUSHKIN, SG, Vol. 1, Nov. '60.—Cities of the Soviet Union. L. M. SOMMERS, EG, Vol. 36, Oct. '60.—Distribution and significance of the foreign trade ports of Norway. V. P. SOTNIKOV, SG, Vol. 1, Dec. '60.—Farming problems in the U.S.S.R. and tasks of Soviet geographers. R. N. TAAFE, UCH, No. 64, '60.—Rail transportation and the economic development of Soviet Central Asia. G. A. TASKIN, GR, Vol. 51, Apr. '61.—Soviet Northwest: economic regionalization. S. M. USPENSKIY, PN, No. 1, '58.—Wealth and conservation of the animal resources of the Soviet Arctic. S. Van VALKENBURG, EG, Vol. 36, Oct. '60.—Evaluation of the standard of land use in Western Europe. V. S. VARLAMOV, SG, Vol. 2, June '61.—Economic-geographic situation of Orenburg, Russia. P. V. VASIL'YEV, SG, Vol. 1, Dec. '60.—Geographic study and economic use of forests, in Russia. S. L. VENDOROV and G. P. KALININ, SG, Vol. 1, June '60.—Surface-water resources of the U.S.S.R.: Their utilization and study. K. V. ZVORYKIN and G. V. CHESHIKIN, SG, Vol. 1, Sept. '60.—Geographic study of the natural characteristics and the economic utilization of the land areas of the U.S.S.R.

ASIA. Physical. R. ANDRE and others, Supplement to LG, No. 1, Publication No. 5, '61.—Les climats de l'Asie. W. L. DALE, JTG, Vol. 13, Dec. '59 and Vol. 14, July '60.—Rainfall of Malaya (*). A. GEDDES, IBG, No. 28, '60.—Alluvial morphology of the Indo-Gangetic Plain: mapping and geographical significance (*). S. K. GHOSE, GRI, Vol. 21, Dec. '59.—Climatic pattern of India. Yu. P. PARMUZIN, SG, Vol. 1, Jan.-Feb. '60.—

Zonal character of the cold Pole. R. N. TIKKA, GRI, Vol. 21, Mar. '60.—Analysis of weather types of Delhi (bio-climatology).

ASIA. Cultural. N. AHMAD and L. RAHMAN, OG, Vol. 4, July '60.—Large-scale industries in Dacca area. W. H. AL-KHASHAB, UCH, No. 54, Dec. '58.—Water budget of the Tigris and Euphrates Basin (*). F. BARTH, NGT, Vol. 17, Nos. 1-4, '59-'60.—Land-use pattern of migratory tribes of South Persia. D. C. BENNETT, EG, Vol. 37, Jan. '61.—Basic food crops of Java and Madura. H. BOBEK, MW, Vol. 101, Heft 3, '59.—Studies in Persia 1958/59 (in German). S. C. BOSE and others, GRI, Vol. 22, June '60.—Report on Sundarbans survey. T. F. BOUSHY, MPG, Vol. 45, Pt. II, '60.—Claims of the Arab and the Jew to Palestine. K. BUCHANAN, PV, Vol. 1, Sept. '60.—China: Measuring a revolution. O. CAROE, GJ, Vol. 126, Sept. '60.—Geography and ethnics of India's northern frontiers (*). M. K. ELAHI, OG, Vol. 4, Jan. '60.—Factory industries in Lahore. ENAYETULLAH, OG, Vol. 5, Jan. '61.—Power resources of East Pakistan. B. H. FARMER, IBG, No. 28, '60.—On not controlling subdivision in paddy-lands. L. H. GULICK, OG, Vol. 5, Jan. '61.—East Pakistan settlements in the Lower Sind Barrage area, West Pakistan. S. Das GUPTA, GRI, Vol. 22, Sept. and Dec. '60.—The changing map of India. T. HERMAN, GR, Vol. 51, Jan. '61.—Economic development of China. Studies reviewed in tranquillity. P. P. KARAN, J of G, Vol. 60, Feb. '61.—Sikkim and Bhutan: A geographical appraisal. P. P. KARAN, OG, Vol. 4, July '60.—Land-use mapping in Nepal. Y. KARMON, GR, Vol. 50, Apr. '60.—Drainage of the Huleh swamps. S. D. KAUSHIC, GRI, Vol. 21, Dec. '59.—Types of human settlement in Jaunsar Himalaya. F. K. KHAN, OG, Vol. 4, Jan. '60.—Agricultural origins in East Pakistan and adjoining areas. W. KIRK, SG, Vol. 76, Apr. '60.—Sino-Indian frontier dispute: A geographical review. C. KUO-CHUN, FO, Vol. 10, Apr. '60.—China's agriculture. A. T. A. LEARMONTH, GJ, Vol. 127, Mar. '61.—Medical geography of India and Pakistan. B. A. LUNIN, SG, Vol. 1, May '60.—Origin and extent of the name Tien Shan. J. W. MACNAB, PV, Vol. 1, Sept. '60.—Agriculture and social change in Japan. A. A. MICHEL, EG, Vol. 36, Oct. '60.—On writing the geography of strange lands and faraway places—Afghanistan, for example. C. W. MITCHELL and P. E. NAYLOR, GJ, Vol. 126, Dec. '60.—Soils and agriculture of the middle Diyala region of eastern Iraq. S. A. NIKOLAYEV and L. I. MOLODTSOVA, SG, Vol. 1, Oct. '60.—Chinese iron and steel industry. OOI JIN-BEE, JTG, Vol. 12, Mar. '59.—Rural development in Tropical areas, with special reference to Malaya. J. E. ORCHARD, A of G, Vol. 50, Sept. '60.—Industrialization in Japan, China mainland and India—some world implications. I. Kh. OVDIYENKO, SG, Vol. 2, Jan. '61.—Structure and distribution of China's industry. I. Kh. OVDIYENKO, SG, Vol. 1, Apr. '60.—New geography of industry of China. D. V. PANFILOV, SG, Vol. 1, May '60.—Location of the boundary between the tropical and subtropical landscapes in Eastern Asia. V. F. PAVLENKO, IANS, No. 2, '61.—Development of the productive forces of Central Asia (in Russian). T. F. RASMUSSEN, JTG, Vol. 14, July '60.—Population and land utilization in the Assam Valley. W. RIECK, MW, Vol. 101, Pt. 2, '59.—Development and extensions of the new China railway network (in German). M. SHAFI, EG, Vol. 36, Oct. '60.—Measurement of agricultural efficiency in Uttar Pradesh. A. SHARON, TPR, Vol. 25, Jan. '55.—Collective settlements in Israel. A. H. SIDDIQI, OG, Vol. 4, July '60.—Olive cultivation in north-east Baluchistan. A. H. SIDDIQI, OG, Vol. 4, July '60.—Industries in the Lower Indus Basin. B. SINHA, GRI, Vol. 21, Mar. '60.—Large-scale medium and cottage industries in Orissa. K. SITA, IGJ, Vol. 35, Nos. 1-2, '60.—Dry farming in Peninsular India. E. L. ULLMAN, GR, Vol. 50, Apr. '60.—Trade centers and tributary areas of the Philippines (*). M. W. WARD, PV, Vol. 1, Sept. '60.—Recent population growth and economic development in Asia. E. WINKLER, MW, Vol. 101, No. 3, '59.—The tobacco industry of Samsun, Turkey (in German). F. D. YAROSHENKO, SG, Vol. 1, Apr. '60.—Electric power development in India.

AFRICA. Physical. K. M. BARBOUR, GR, Vol. 51, Jan. '61.—Maps of Africa before surveys. The "location of Omodias map" of Sudan. W. HAUDE, GA, Vol. 41, No. 1, '59.—Evaporation and the water balance in the Nile Basin (in German). L. A. and L. C. KING, SAJ, Vol. 41, Dec. '59.—Reappraisal of the Natal monocline. J. R. V. PRESCOTT and H. P. WHITE, GJ, Vol. 126, June '60.—Sand formations in the Niger Valley between Niamey and Bourem. R. SAID, BE, Vol. 33, '60.—New light on the origin of the Qattara depression (Western desert of Egypt) (*).

AFRICA. Cultural. R. ANDRE, LG, Vol. 13, Pt. 1, '61.—Maroc. D. H. BUCKLE, A of Sc, Vol. 17, Mar. '61.—Aspects of investment in under-developed countries—Africa. R. J. H. CHURCH, SR, Vol. 7, July '59.—West African urbanisation. R. J. H. CHURCH, GJ, Vol. 127, June '61.—Problems and development of the dry zone of West Africa. W. DESHLER, GR, Vol. 50, Oct. '60.—Livestock trypanosomiasis and human settlement in northeastern Uganda. W. S. DOUGLAS, TA, Vol. 1, Sept. '59.—Deciduous fruit industry of the Cape. T. J. D. FAIR and E. W. N. MALLOW, TPR, Vol. 30, July '59.—Southern

Transvaal: An emerging metropolitan complex in Africa. D. K. FIAWOO, SR, Vol. 7, July '59.—Urbanisation and religion in eastern Ghana. H. J. R. HENDERSON, IBG, No. 28, '60.—Dairying industry in South Africa. T. E. HILTON, OG, Vol. 5, Jan. '61.—Fisheries of the Volta system of Ghana. D. LEWIS-WILLIAMS, TA, Vol. 1, Apr. '60.—Development of East London Harbour (Cape Province). M. P. MARTHELOT, BAGF, Nos. 296-7, Jan.-Feb. '61.—La modernisation du monde rural au Maroc. J. MATZNETTER, MW, Vol. 102, Pt. 1, '60.—Cape Verde Islands (in German*). E. E. MELVIN, J of G, Vol. 40, Jan. '61.—Native urbanism in West Africa. E. MIGLIORINI, RGI, Vol. 66, No. 2, '59.—New contributions to the knowledge of interior Libya (in Italian). G. P. MURDOCK, GR, Vol. 50, Oct. '60.—Staple subsistence crops of Africa. A. NEL, TA, Vol. 1, Sept. '59.—Compiling a population map of Africa (*). N. C. POLLOCK, SAJ, Vol. 41, Dec. '59.—Agrarian revolution in Kikuyuland. N. C. POLLOCK, EG, Vol. 36, Oct. '60.—Industrial development in East Africa. J. R. V. PRESCOTT, GJ, Vol. 127, June '61.—Overpopulation and overstocking in the native areas of Matabeland. W. H. REEVE, GJ, Vol. 126, June '60.—Progress and geographical significance of the Kariba Dam. P. SMIT and A. NEL, TA, Vol. 1, Sept. '60.—Recent developments and trends in Africa. Africa's changing political pattern. P. VENNETIER, RGL, Vol. 36, No. 1, '61.—Mvouti, une agglomération semi-urbaine dans la République du Congo. O. WILLIAMS, SAJ, Vol. 41, Dec. '59.—Power sources and fuel supplies of the secondary industries of Natal. O. WILLIAMS and B. S. YOUNG, TA, Vol. 1, Sept. '60.—Map of the main agricultural regions of South Africa.

NORTH AMERICA. Physical. F. AHNERT, A of G, Vol. 50, June '60.—Influence of Pleistocene climates upon the morphology of Cuesta scarps on the Colorado Plateau. F. AHNERT, GR, Vol. 50, July '60.—Estuarine meanders in the Chesapeake Bay area (Maryland). H. ASCHMANN, A of G, Vol. 49, Pt. 2, Sept. '59.—Evolution of a wild landscape and its persistence in Southern California. P. BIAYS, CGQ, Vol. 4, Apr.-Sept. '60.—Le courant du Labrador et quelques-unes de ses conséquences géographiques. F. A. COOK, GB, No. 13, '59.—Periglacial phenomena in Canada (F). F. A. COOK, GB, No. 13, '59.—Types of patterned ground in Canada (F). E. DERBYSHIRE, GA, Vol. 42, No. 1, '60.—Glaciation and subsequent climatic changes in Central Quebec-Labrador. L. H. HORN and R. A. BRYSON, A of G, Vol. 50, June '60.—Harmonic analysis of the annual march of precipitation over the United States. J. R. MACKAY, GB, No. 13, '59.—Glacier ice-thrust features of the Yukon coast. D. S. SIMONETT, A of G, Vol. 50, Sept. '60.—Development and grading of dunes in Western Kansas. F. B. WATTS, GB, No. 14, '60.—Natural vegetation of the southern Great Plains of Canada.

NORTH AMERICA. Cultural. G. ALEXANDERSSON, EG, Vol. 37, Apr. '61.—Changes in the location pattern of the Anglo-American steel industry, 1948-1959. A of G, Vol. 49, Sept. '59.—Bibliography of California. L. BEAUREGARD, RCG, Vol. 13, Jan.-June '59.—La plaine du Richelieu banlieue agricole de Montréal. W. A. BLACK, A of G, Vol. 50, Sept. '60.—Labrador floater codfishery. J. R. BORCHERT, GR, Vol. 51, Jan. '61.—Twin cities urbanized area: Minneapolis and St. Paul, Minnesota (*). A. F. BURGHARDT, A of G, Vol. 49, Sept. '59.—Location of river towns in the central lowland of the United States. F. A. CARLSON, J of G, Vol. 59, Nov. '60.—Traffic on the Ohio river system. G. F. CARTER, A of G, Vol. 49, Pt. 2, Sept. '59.—Man, time and change in the far southwest. M. M. COLBY, UCH, No. 58, '58.—Geographic structure of southeastern North Carolina. W. B. FISHER, A of Sc, Vol. 17, July '60.—Twenty-five years of Tennessee Valley Authority. V. M. GOKHMAN, SG, Vol. 2, June '61.—Geography of industry in the United States. J. F. HART, A of G, Vol. 50, Sept. '60.—Changing distribution of the American Negro. R. R. KRUEGER, GB, No. 14, '60.—Changing land uses in the Niagara fruit belt. P. F. LEWIS, A of G, Vol. 50, June '60.—Linear topography in the southwestern Palouse, Washington-Oregon. P. D. MCGOVERN, SGM, Vol. 76, Dec. '60.—British Columbia natural resources conference. An approach to co-ordinated regional development. G. MANNERS, SGM, Vol. 76, Dec. '60.—Public transport policy and the railways of the U.S.A. R. S. MATHIESON, A, Vol. 8, Sept. '60.—Economic trends in the Alaskan salmon industry. H. J. NELSON, A of G, Vol. 49, Pt. 2, Sept. '59.—Spread of an artificial landscape over Southern California. A. PECORA, GNS, Vol. 5, Mar.-Apr. '60.—The port of New York (in Italian). R. S. PLATT, UCH, No. 61, '59.—Field study in American geography: The development of theory and method exemplified by selections. E. T. PRICE, A of G, Vol. 49, Pt. 2, Sept. '59.—Future of California's southland. V. F. PUZANOVA, PN, No. 1, '58.—Mining industry of northwest Canada. H. F. RAUP, A of G, Vol. 49, Pt. 2, Sept. '59.—Transformation of Southern California to a cultivated land. E. ROSTLUND, A of G, Vol. 50, Dec. '60.—Geographic range of the historic bison in the Southeast. W. L. THOMAS, A of G, Vol. 49, Pt. 2, Sept. '59.—Man, time and space in Southern California. D. WEBER, UCH, No. 60, '58.—A comparison of two oil city business centers (Odessa-Midland, Texas). C. L. WHITE and H. M. FORDE, J of G, Vol. 59, Sept. '60.—Unorthodox San Francisco Bay area electronics industry. G. F. WHITE (Editor),

UCH, No. 70, '61.—Papers on flood problems. G. F. WHITE and others, UCH, No. 57, '58.—Changes in urban occupancy of flood plains in the United States. M. R. WOLFE, TPR, Vol. 28, July '57.—Urbanisation and a new town in the Columbia Basin (Missouri).

LATIN AMERICA. H. ASCHMANN, A of G, Vol. 50, Dec. '60.—Indian pastoralists of the Guajira Peninsula. J. P. AUGELLI and H. W. TAYLOR, A of G, Vol. 50, June '60.—Race and population patterns in Trinidad. A. L. BURT and others, EG, Vol. 36, July '60.—Santo Domingo de Los Colorados—A new pioneer zone in Ecuador. J. P. COLE, TPR, Vol. 27, Jan. '56.—Town planning problems of Greater Lima, Peru. M. M. COLE, GJ, Vol. 126, June '60.—Cerrado, Caatinga and Pantanal: The distribution and origin of the Savanna vegetation of Brazil. C. COTTON, GJ, Vol. 126, Dec. '60.—Origin and history of Central-Andean relief: Divergent views. J. DEMANGEOT, RGA, Vol. 49, No. 1, '61.—Problèmes morphologiques du Mato Grosso central. J. GRULL, MW, Vol. 101, Pt. 1, '59.—Orinoco iron ores: Factor in the economic development of Venezuela (in German). L. H. GULICK, OG, Vol. 4, July '60.—A Puerto Rican coffee hacienda. G. HOLZMANN, MW, Vol. 101, Pt. 3, '59.—Japanese settlers in Brazil (in German). M. C. MEGEE, UCH, No. 59, '58.—Monterrey, Mexico: Internal patterns and external relations. W. E. RUDOLPH, GR, Vol. 50, Oct. '60.—Catastrophe in Chile. E. SHIPTON, GJ, Vol. 126, Dec. '60.—Volcanic activity on the Patagonian Ice Cap. C. T. SMITH, GJ, Vol. 126, Dec. '60.—Aspects of agriculture and settlement in Peru (*). N. R. STEWART, EG, Vol. 36, July '60.—Tea—A new agricultural industry for Argentina.

AUSTRALASIA AND OCEANIA. M. ANAS, GR, Vol. 50, Oct. '60.—Highlands of Australian New Guinea. J. BARRAU, PV, Vol. 1, Mar. '60.—Plant introduction in the Tropical Pacific. F. H. BAUER, A, Vol. 7, Aug. '59.—Sheep raising in northern Australia. H. BELSHAW, PV, Vol. 1, Sept. '60.—Some Pacific Island problems. J. BOOTH, PV, Vol. 1, Mar. '60.—The Maori in town and country. H. C. BROOKFIELD, A, Vol. 7, Feb. '60.—Population distribution and labour migration in New Guinea. C. J. BURROWS, NG, Vol. 16, Apr. '60.—Recent changes in vegetation of the Cass area of Canterbury. C. S. CHRISTIAN and others, A, Vol. 7, Feb. '60.—Land research in Northern Australia. G. R. COHRANE, A, Vol. 8, Sept. '60.—Intensive land use in South Australia's Upper Murray. C. COTTON, GJ, Vol. 127, June '61.—Growing mountains and infantile islands on the Western Pacific rim. L. CURRY, NG, Vol. 16, Apr. '60.—Atmospheric circulation in the Southern South Pacific. J. L. DAVIES, A, Vol. 8, Sept. '60.—Beach alignment in Southern Australia. E. J. DONATH, PV, Vol. 1, Mar. '60.—Post-war migration to Australia. C. DUNCAN, GR, Vol. 51, Jan. '61.—Aluminum industry in Australia. E. A. FITZPATRICK, JTG, Vol. 14, July '60.—Some climatic implications in the mid-February (1959) tropical cyclone over Eastern Australia. S. H. FRANKLIN, PV, Vol. 1, Sept. '60.—Village and the bush. The evolution of the village community, Wellington Province, New Zealand. R. G. GOLLEDGE, A, Vol. 7, Feb. '60.—Sydney's metropolitan fringe: A study in urban-rural relations. R. P. HARGREAVES, NG, Vol. 16, Apr. '60.—The Golden Age: New Zealand about 1867. W. HOLFORD, TPR, Vol. 29, Oct. '58.—Future of Canberra. T. F. KENNEDY, EG, Vol. 37, Jan. '61.—Land, food and population in the Kingdom of Tonga. H. W. H. KING and E. R. WOOLMINGTON, A, Vol. 8, Sept. '60.—Role of the river in the development of settlement in the Lower Hunter Valley. T. LANGFORD-SMITH, GR, Vol. 50, July '60.—Dead River systems of the Murrumbidgee. G. J. R. LINGE, EG, Vol. 36, Oct. '60.—Concentration and dispersion of manufacturing in New Zealand. D. W. MEINIG, A, Vol. 7, Aug. '59.—Colonization of wheatlands: Some Australian and American comparisons. M. PARDE, RGA, Vol. 48, No. 3, '60.—Le régime des rivières en Nouvelle-Zélande. L. L. POWNALL, A of G, Vol. 50, Dec. '60.—Low-value housing in two New Zealand cities (Inner Christchurch and Inner Dunedin). E. REINER, GR, Vol. 50, Oct. '60.—Glaciation of Mount Wilhelm, Australian New Guinea. K. W. ROBINSON, GR, Vol. 51, Jan. '61.—Sixty years of federation in Australia. R. J. SOLOMON, A, Vol. 7, Aug. '59.—Broken Hill. The growth of the settlement, 1883-1958. R. G. WARD, NG, Vol. 16, Apr. '60.—Village agriculture in Viti Levu, Fiji. R. F. WATTERS, JTG, Vol. 14, July '60.—Some forms of shifting cultivation in the South-west Pacific.

Publications of the Geographical Association



Geography The Journal of the Association.

10s. 6d. per part.

Published four times a year, containing articles on geographical as well as on teaching topics; "This Changing World" to keep geography teachers up to date; book reviews and lists; news of interest to geographers.

Members of the Association receive four parts of *Geography* free on the Annual Subscription (£2) due 1st September.

Geography in Secondary Schools E. W. H. BRIAULT and D. W. SHAVE

2s.

Teaching Geography in Junior Schools

A handbook for teachers in primary schools, but useful also for lower school reference in secondary schools. Chapters on syllabus planning, local geography, field work, maps, atlases and globes; appendices on sources of material for sample studies, settlement studies and other teaching techniques.

3s. 6d.

British Landscapes through Maps

A series, edited by Professor K. C. EDWARDS, of books describing the areas depicted on various Ordnance Survey maps with map and photo illustrations.

No. 1. The English Lake District by F. J. MONKHOUSE (The Lake District Tourist Map).

No. 2. The Yorkshire Dales by C. A. M. KING (O.S. Map sheet 90; Wensleydale).

No. 3. Guernsey by H. J. FLEURE Each (3s. 6d. to members) 4s. 6d.

Books in this series give detailed references (with Grid References) to aspects of the geography of the areas they describe; other titles are to be published later. They are accompanied by a second series:

Exercises on Ordnance Survey Maps

A series prepared by the Secondary Schools Section Committee of the Geographical Association, planned for secondary school use selectively throughout the school.

No. 1. The Lake District 1s. 6d.

No. 2. The Yorkshire Dales. Includes exercises on pictures. 1s. 6d.

Studies in the Geography of the South West Peninsula

2s.

S. W. WOOLRIDGE, A. DAVIES and A. H. SHORTER

The Sussex Rivers

2s.

D. L. LINTON

Some Aspects of Desert Geomorphology

1s. 6d.

R. F. PEEL

The Theory of Savanna Planation

1s. 6d.

C. A. COTTON

Geography Room Plans, compiled by the Secondary Schools Section.

1s. 6d.

Catalogues of the Library of the Geographical Association

Asia. 3s. 6d. (2s. 6d. to members). **Africa.** 3s. (2s. to members).

North and Latin America. 4s. 6d. (3s. 6d. to members).

Order publications direct from

THE GEOGRAPHICAL ASSOCIATION

THE PARK BRANCH LIBRARY

DUKE STREET

SHEFFIELD 2

Good description of Tropical forest.

CONTENTS

CLIMATE AND THE GEOMORPHIC CYCLE <i>A. Austin Miller</i>	185
SOME DEVELOPMENTS IN CLIMATOLOGY DURING THE LAST DECADE <i>G. B. Tucker</i>	198
ATMOSPHERIC CIRCULATION, CLIMATE AND CLIMATIC VARIATIONS <i>H. H. Lamb</i>	208
INTERNATIONAL TIN RESTRICTION AND ITS EFFECTS ON THE MALAYAN TIN MINING INDUSTRY <i>P. P. Courtenay</i>	223
BLACKBOARD AND CAMERA. SOME COMBINED USES IN THE TEACHING OF GEOGRAPHY <i>P. J. M. Bailey</i>	232
THIS CHANGING WORLD	
THE 1961 CENSUS OF ENGLAND AND WALES. <i>R. Lawton</i>	238
LE REMEMBREMENT EN FRANCE. A CASE STUDY FROM LORRAINE. <i>I. B. Thompson</i>	240
DEVELOPMENTS IN THE LORRAINE IRON AND STEEL INDUSTRY. <i>J. E. Martin</i>	242
THE NEW RAILWAY AND PORT IN NORTHERN ECUADOR <i>A. M. S. Graham and D. A. Preston</i>	245
THE DEVELOPMENT OF PORT KEMBLA, N.S.W. <i>J. N. H. Britton</i>	247
DEVELOPMENTS IN SOUTHLAND, NEW ZEALAND. THE PORT OF BLUFF. <i>Marion MacFarlane</i>	250
CONDITIONS AND TRENDS IN THE HIGH MOUNTAIN WATERSHEDS OF NEW ZEALAND. <i>J. T. Holloway</i>	252
A SIXTH-FORM GEOGRAPHY CONFERENCE. A REPORT <i>K. Briggs</i>	254
THE GEOGRAPHICAL ASSOCIATION	257
REVIEWS OF BOOKS AND ATLASES	261
RECENT GEOGRAPHICAL ARTICLES	277

The authors alone are responsible for the opinions expressed in their articles.

Manuscripts are invited for consideration by the Editorial Board for publication in *Geography*; a leaflet of information for contributors can be obtained from the Honorary Editor. Articles of appropriate length are also invited for "This Changing World". Manuscripts submitted for publication and books for review should be addressed to the Honorary Editor, The Geographical Association, c/o The Park Branch Library, Duke Street, Sheffield 2.

Inquiries for advertisement space in *Geography* should be addressed to the Assistant Editor, The Geographical Association, c/o The Park Branch Library, Duke Street, Sheffield 2.